THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XVII JUNE, 1927 No. 6

THE RELATION OF CHEMICAL, COLLOIDAL AND BIOLOGICAL EFFECTS OF ROENTGEN RAYS OF DIFFERENT WAVE LENGTHS TO THE IONIZATION WHICH THEY PRODUCE IN AIR

I. ACTION OF ROENTGEN RAYS ON SOLUTIONS OF OXYHEMOGLOBIN IN WATER

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IN recent years a large number of investigations have been made to determine the relation of different biological effects of roentgen rays to the ionization which they produce in air in its dependence on the wave length of the rays. These investigations are very important because of their bearing upon the practical therapeutic application of the roentgen ray; but of equal importance is the information which may be derived from these studies regarding the nature of the action of roentgen rays on the biological cell. In this report we shall give the results of different investigations which we have made in the hope of throwing light upon this last problem.

In our first investigations we have studied the chemical action of roentgen rays on homogeneous solutions. In accordance with a law which, as we shall see presently, is of fundamental importance for this whole problem, the result of these investigations may be so expressed that by a constant ratio of the amounts of energy absorbed in the irradiated solution and in the air, the relationship of the chemical effect and the ionization is independent of the wave length. On the basis that the average intensity of the rays in the solution and in the air is equal, this relationship therefore depends on the ratio of the two coefficients of absorption. As is well known, the total absorption of roentgen rays is the sum of the photo-electric absorption and the Compton absorption. The photo-electric absorption can at present be determined experimentally only for the heavier elements; for these it varies at least very nearly in the same way with the wave length for the different elements and undoubtedly this will hold true also for the lighter elements with which we are dealing here. Furthermore we may theoretically expect that the Compton absorption per gram-electron would be very nearly the same for elements which are not very far apart in the periodic table. On these assumptions the condition for a constant ratio of the two coefficients of absorption is that the photo-electric absorption per gram-electron shall be the same for the chemical system and for the air. We have expressed this condition before by stating that the effective atomic numbers of the two systems must be the same. (With the photo-electric absorption per gram-electron varying as the third power of the atomic number, the effective atomic num-

ber of the compound $n_1A + n_2B \ldots$, composed of n_1 atoms of atomic number A, etc., is $N_{eff} = \left[\frac{n_1A^4 + n_2B^4 + \cdots}{n_1A + n_2B + \cdots}\right]^{1/3}$. Therefore if the irradiated solution contains only lighter elements, we may expect that if the effective atomic number of the solution is equal to that of air, the relationship of chemical effect and of ionization will be independent of the wave length.

If the effective atomic numbers are different, this independence will still hold for the longer wave lengths for which the Compton absorption is inappreciable, while for the shorter rays the chemical effect will be too small or too large, according as the effective atomic number of the solution is larger or smaller than that of air. Quantitatively the relation is expressed by the equation $\frac{C_1N^3(\text{air}) + C_2}{C_1N^3(\text{solution}) + C_2}$ when C_1N^3 and C_2 are the photo-electric and Compton absorptions respectively. We have tested this equation by adding salts such as potassium chlorid to the irradiated solutions and found a good agreement with Compton's theory.

This effect may well be of importance in its relation to the action of roentgen rays on the biological cell. It is true that the effective atomic number of the biological cell as a whole is about the same as that of air; but undoubtedly it is not the average composition of the cell as a whole that counts, because probably the deciding action of the rays affects only a small part of the cell, the effective number of which may well be different from that of the cell as a whole. For instance, this part of the cell may have a comparatively high content of mineral salts such as potassium chlorid, in which case its effective atomic number would be rather high. Of course the effective atomic number would depend on the wave length, if the length of the path of the secondary photo-electrons is of the same order as the dimensions of this part of the cell.

The problem of the relationship of the biological effects of roentgen rays to their ionization in air is a special case of the general problem of the dependence of the relationship of any two effects of roentgen rays on the wave length. This problem is of both theoretical and practical interest to physicists, and different investigations bearing on it have been made. For instance, comparison has been made (1) of the ionizations produced by roentgen rays in different gases; (2) of the photographic effect of roentgen rays and the ionization they produce in air; (3) of the ionization produced in air and (4) the energy absorbed; and (5) of the chemical effect of different radioactive rays and their ionization in air. The problem is still in an unsettled state; there is, however, no doubt that the law stated above, that the effect of roentgen rays on a system when a constant amount of energy is absorbed is independent of the wave length of the rays, has a wide range of applicability, although it may not hold in all cases.

We may obtain an understanding of this law by making use of the picture of the quantum theory of the atom. Thus when roentgen rays are absorbed we may assume that through the medium of the fast secondary electrons all the energy of the roentgen rays is used to carry a certain number of molecules over into certain excited states, and that all effects of the roentgen rays which we observe are primarily due to these excited molecules. One law which therefore evidently is of fundamental importance for our problem is the one which governs the dependence of the relative probability for the production of the different types of excited molecules on the velocity of the exciting electron. It is theoretically probable that for the high velocities of the secondary electrons with which we are dealing, this probability is independent of the velocity. If this is so, we may conclude that the number of excited molecules of any type which is produced is dependent only on the total energy absorbed, and any effect which is dependent only on the number of the different excited molecules would therefore be independent of the wave length when a constant amount of energy is absorbed. This would be the case for the ionization of a gas or the chemical effect of the rays in a homogeneous liquid. However, it is probable that there will be cases in which the length of the path and the density of the excited

molecules along the path of the secondary electrons are of importance in the production of the final effect. This, for instance, might well be expected to be true of effects produced in disperse mediums like biological cells, if the size of the disperse phases is of the order of the length of the path of the secondary electron.* In such cases we may then have effects which will show dependence on the wave lengths.

The theory outlined above has been tested for two reactions, the oxidation of ferrosulphate (to ferrisulphate) and the oxidation of oxyhemoglobin (to methemoglobin), both in diluted watery solution. These reactions are typical of a group of reactions for which we may assume that the primary action of the rays takes place on the water molecules, a certain number of active modifications of the water molecule being produced to which the finally observed transformations are due. If the water is pure, all or certain of these active molecules will, as is well known, be transformed to hydrogen and oxygen gas and partly also to hydrogen peroxid.

According to our investigations and as was to be expected theoretically, the total number of active molecules produced in water is of the same order as the number of ions produced in the same weight of air; that is, for a dose of 1 Kilo-Roentgen a number corresponding to a concentration of the order of 10^{-3}n.† To obtain appreciable percentile effects in reactions of this kind we must therefore work with very dilute solutions; we have usually worked with concentrations of the order of 10^{-3}n, using doses of the order of 50 K-R. A closer study of these reactions is very attractive, not alone theoretically but also from the point of view of working out a practical chemical dosimeter. We hope later to be able to give some contributions to this problem; at present, however, we have had little occasion for a systematic study, although different observations which may be found of interest will be reported in the description of our experiments.

For technical reasons our investigations on oxyhemoglobin will be reported first.

* The investigations of the photographic plate of Berthold and Glocker[2] is interesting from this point of view.

† A dose of about 50K-R. will transform completely a $\frac{1}{1000}$n ferrosulphate solution.

EXPERIMENTAL TECHNIQUE

Production of Radiations. For most of the effects studied a much greater roentgen-ray intensity is necessary than that which can be produced by the standard roentgen-ray tubes. We therefore have constructed special tubes, the most important points in the design of which are a small diameter and a large current capacity. Furthermore, these tubes are made of lithium glass whereby a very considerable increase of the intensity of the long radiations is obtained. The diameter of the tubes at present employed is 7 centimeters, although one could easily make them much smaller. The anode is water cooled and the tube will stand an input of about 5 kw. without heating the water to the boiling point. At present the current through the tube is limited by the maximum carrying capacity of the mechanical rectifier, which is about 40 ma. We have constructed tubes with anodes of different metals. In our first investigations in which high homogeneity has not been so important, we have for convenience used only a tungsten tube. The different radiations were produced by the use of different selective filters. Three radiations have been employed, by the use of a molybdenum, a tin, and a copper filter. Our focal distance has been 10 cm. The intensity of the radiations at this distance is about 40,000 Roentgen per hour. The radiations are defined as follows:

TRANSFORMER WITH MECHANICAL RECTIFICATION
Lithium glass tube. Tungsten target

I. Potential: 105 kv. (as measured with a 12.5 cm. sphere gap)
Current: 25 ma.
Filter: 0.38 mm. copper plus 0.5 mm. aluminum.

λ eff by absorption in	
Copper	0.248 Å
Molybdenum	0.249 Å
Silver	0.245 Å
Tin	0.248 Å

II. Potential: 60 kv.
Current: 40 ma.
Filter: 0.20 mm. Tin

λ eff by absorption in	
Aluminum	0.527 Å
Molybdenum	0.439 Å
Silver	0.632 Å
Tin	0.562 Å

III. Potential: 40 kv.
Current: 40 ma.
Filter: 0.0316 gr. sq. cm. Molybdenum

λ eff by absorption in	
Aluminum	0.754 Å
Molybdenum	0.708 Å
Silver	0.754 Å

We have not determined the spectral composition of these radiations. Determinations of the effective wave lengths corresponding to a few different selective filters are given by which some idea of the composition of the radiations may be obtained. It will be seen by a study of these that radiation I does not contain any radiation longer than the critical wave length of tin $\lambda = 0.42$ Å. Radiation III contains a small amount (a rough calculation gives about 10 per cent) of rays shorter than the critical wave length of molybdenum $\lambda = 0.62$ Å; radiation II finally is for the greater part composed of rays between these two limits—0.42 Å and 0.62 Å—for the two other radiations, although an appreciable part of it extends beyond. A calculation shows that approximately 60 per cent of radiation II lies between 0.42 Å and 0.62 Å, while 40 per cent is beyond these limits with about an equal amount to either side.

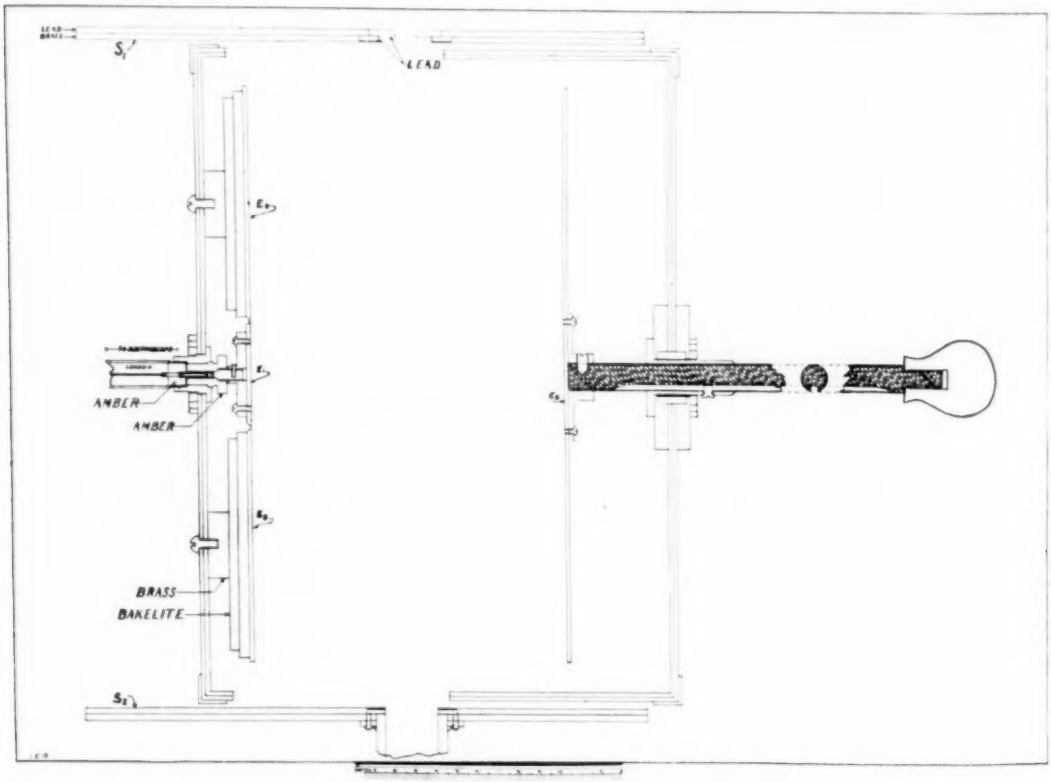

FIG. 1. Standard air ionization chamber.

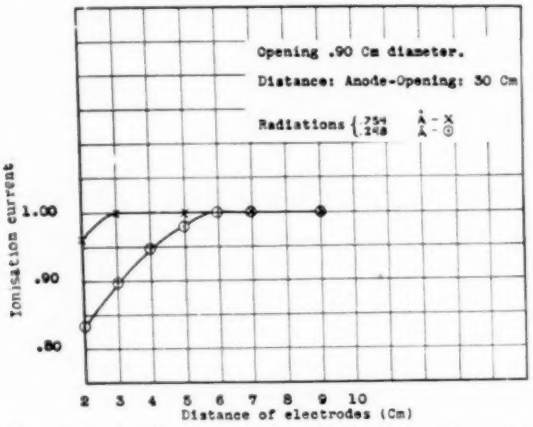

FIG. 2. Ionization current in standard chamber I for different distances between electrodes.

Measurement of Ionization. The ionization was determined by means of a large ionization chamber. For control, two chambers were constructed of which one (No. I) was about 50 per cent larger than the other (No. II) in all dimensions. Figure 1 shows a diagram of the larger

chamber, the essential points in the design of which are familiar. The collecting electrode E_1 ($4.98_3 \times 20$ cm.) is placed between two guarding electrodes E_2 (11×20 cm.). The adjacent ends of these electrodes are cut off with a sharp edge so as to diminish the probability of the entrance of dust between them; the electric capacity of E_1 in relation to E_2 is also thereby reduced and small changes which may occur in the distance between the electrodes—E_1 and E_2—cause minimum changes in the capacity of the insulated system. The distance between E_1 and E_2 is 0.35 mm., which is less than 1 per cent of the length of E_1. As the effective length of E_1 we take 5.02 cm. E_1 and E_2 are stationary; they are mounted in a brass box which is completely surrounded by lead, 1 mm. in thickness except in the front, where 3 mm. lead is used. With the very small amount of scattered radiation in the room, this protection is ample; and when the front slit of the chamber is closed, the electroscope shows no observable leakage. All parts of the inside of the chamber are painted with India ink. At the front of the box is mounted a slide S_1 which carries the entrance slit, which is covered with 0.01 mm. celluloid. At the back of the box is another slide S_2 which carries the exit slit, a circular hole 2.5 cm. in diameter over which is mounted a lead tubing 10 cm. in length. These slides can move over half of the width of the chamber. The electrode E_3 can move over 15 cm. It is supported by an insulated mounting and can be charged up to +1600 volts by means of a D. C. generator. We use a potential of at least 200 volts per cm. between E_1 and E_3, which is always sufficient for a saturation current. The potential of E_1 is about −200 volts; it discharges over $22\frac{1}{2}$ volts and the guarding electrodes E_2 are kept at the potential of E_1 when half discharged; a change of the potential of E_2 of 6 volts changes the current to E_1, about 1 per cent, when the electric force between E_1 and E_3 is 200 volts per cm.

For each irradiation, different tests of this chamber were made. The most important of these tests for us here is that in which the position of the electrode E_3 is changed, the entrance and exit slits being kept centered. Figure 2 shows the results of this test for radiations I and III. In the final experiments we used a distance between E_1 and E_3 of – cm., which is always sufficient to obtain the full ionization.

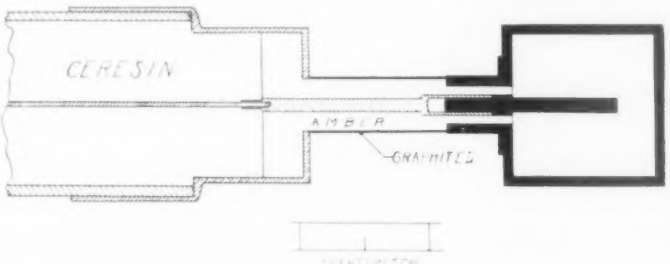

FIG. 3. Graphite ionization chamber.

The large chamber serves as the standard, but the actual radiation of the chemical solutions is controlled by means of a small graphite chamber; it is necessary to use this indirect method because for radiations II and III an appreciable fraction of the ray energy is the characteristic K-radiation from the filter, which fraction, because of the small distance between the filter and the irradiated solution, would not be truthfully recorded by the large ionization chamber. Also, the small chamber will more truthfully record the scattered radiation (always very small) from the irradiated solution. A diagram of this small chamber is given in Figure 3. For a distance of a few centimeters from the chamber the wire which connects the electrode of the chamber with the electroscope is carried inside a very thin (3.5 mm. diameter) amber rod; the front of this rod projects into the chamber, thus serving as insulation for the electrode. The area of the amber inside the chamber is only a few square millimeters. The graphite used in this chamber has been especially prepared

and the amount of impurities is below 0.01 per cent.* The wall of the chamber is 0.30 mm. thick.

The small chamber was compared with both of the large chambers for each radiation used. The small chamber was placed at the center of the entrance slit of the large chamber and readings were taken with the chambers alternately in place. The same electroscope is used in both measurements; the capacity of the electroscope is increased by adding a large condenser (about 1400 $\mu\mu$f) and the difference in the capacity with the large and small chamber in place is therefore small, of the order of 1.5 per cent. The results of the measurements are given in Table 1.† It will be seen that there is a difference of a few per cent between the readings of the two large chambers; this difference is the same for all three radiations and in regard to the variation of the readings with the wave length, with which we alone are dealing, the chambers are therefore identical; there is no reason to doubt the exactness of the values obtained for this variation and we have not tried to determine what the reason is for the difference of the absolute readings of the chambers.

Cells for Irradiation of Solutions. Two different cells were used for the irradiation of the solutions. One which we shall call the "glass cell," consisted of a plane glass about 1 mm. in thickness in which an oblong hole 6 cm. × 3 cm. was cut. Each side of this piece of glass was covered with a plane glass 0.10 mm. thick, the lower of these being held in place by a bakelite frame perforated with soft rubber; the upper glass was kept in position by the capillary force of the liquid, the edge being sealed by the application of a small amount of melted vaseline. It is very important that the cell be tight, since the room where the irradiation takes place is filled with ozone and similar active gases. The irradiated liquid must also be protected from the atmospheric air, because the reactions usually depend on the oxygen pressure (and often on the nitrogen pressure also) in the irradiated solution, the oxygen being more or less completely consumed during an exposure.

The other cell, called the "paraffin cell," consists of a narrow glass ring 3 cm. in diameter and 3 mm. thick, covered with thin (1 mm.) plates of paraffin.

During irradiation the cell is placed on a piece of thin paper suspended under the tube. The opening of the tube-housing is so regulated that the rays fill the area of the liquid, but do not extend much beyond it. The ionization chamber is placed just beneath the cell. Because of the large dimensions of the cells, especially of the glass cell, as in comparison with the focal distance, the intensity of the radiation is different at different points within the cell; but the relative distribution of the intensity is found to be the same for all three radiations. The difference in ray intensity at the chamber and at the center of the cell, however, is not exactly the same for the three radiations, due to the fact mentioned before, that the characteristic radiation from the tin and molybdenum filters forms an appreciable portion of the total ray intensity. The intensity of this

TABLE 1
COMPARISON OF GRAPHITE CHAMBER WITH LARGE STANDARD CHAMBERS

Radiations	Ratio of Ionizations for 1 c.c. of Volume in Standard—and Graphite—Chambers			
	Standard Chamber I		Standard Chamber II	
I (0.248 A)	1.267	1.03	1.235	1.03
II (0.527 A)	1.305	1.07	1.272	1.07
III (0.754 A)	1.217		1.187	

STANDARD CHAMBER:	I	II
Area entrance slits (circular)	1.227 sq. cm.	1.227 sq. cm.
	0.636 "	0.636 "
Insulated electrode	Length 4.083 cm.	2.495
	Eff.* length 5.018	2.52
GRAPHITE CHAMBER: (cylindrical)	Length: 1.098 cm.	
	Diameter: 1.095	
	Eff.† volume: 1.03 sq. cm.	

*Half the distance to guarding electrodes included.
†Electrode volume subtracted.

*We are indebted to the National Carbon Company of Cleveland for the preparation of this graphite.

†In an earlier paper[6] we have reported observations of the ionization current in small chambers of different materials from which we have drawn the conclusion that the ionization in a small chamber which is made of a material with an effective atomic number equal to that of atmospheric air (7.66), would be the same as that of the same volume of air as determined with the large chamber. We should like to take this opportunity to say that the direct comparison which we have made has not verified this conclusion. We have calculated the ionization for the N = 7.66 chamber by equation (b), p. 457 of the earlier report,[6] measuring directly the ionization in small chambers of pure graphite and magnesium (received by the courtesy of the American Magnesium Corporation and stated to be 99.95 per cent pure). The ionization is larger in the small than in the large chamber, the difference being 2 per cent for radiation III and 16 per cent for radiation I. We are uncertain about the reason for this discrepancy; it is not due to any impurity of the small graphite chamber.

portion, of course, increases faster with decreasing distance than does the rest of the radiation, because the filter is so much closer to the cell than is the target. The difference is measured for each irradiation; for irradiations I, II, and III, it is respectively 19 per cent, 22 per cent and 21.5 per cent of the total ray intensity. By placing a piece of lead just large enough to screen the ionization chamber from the rays on the top of the cell we can measure the intensity of the radiation scattered by the cell and the liquid. This amounts to only a few per cent and is about the same for all radiations. We made these measurements because of the possibility that the intensity of the scattered radiation might be different at the site of the ionization chamber and in the liquid, but evidently the error which this effect might cause cannot exceed a portion of 1 per cent.

The absorption of the rays by the filled cell is determined by measuring the ray intensities I_1 and I_2 without the cell and with the cell in place. In nearly all cases the absorption is so slight that it is sufficiently accurate to consider the average intensity of the rays in the liquid as equal to $\sqrt{I_1 I_2}$. In some cases this mode of calculation causes an error of a few per cent and the following more accurate calculation is therefore employed: The absorption of the covers is determined by direct measurement. Usually the lower cover absorbs a little less than the upper on account of the hardening of the rays by their passage through the upper cover and the liquid. I_1 and I_2, corrected for the absorption of the covers, represent the intensities I_1^1 and I_2^1 at the upper and lower surface of the liquid. If the index of absorption of the rays is not changed appreciably by their passage through the liquid, the average intensity of the rays in the liquid is $\int_0^a I_1^1 e^{-\mu x} \cdot dx = I_1^1 \frac{1 - e^{-\mu a}}{\mu a}$, in which a is the thickness of the liquid layer and μa is the index of absorption determined by $\frac{I_2^1}{I_1^1} = e^{-\mu a}$. In certain cases there is a very slight change in this index of absorption. It is sufficiently accurate to consider this change as proportional to the depth of penetration, and a calculation gives for the average intensity:

$$I_1^1 \frac{1 - e^{-\mu a}}{\mu a} \left(1 - \frac{1}{3}\Delta\right),$$

when μa is defined as above and Δ is the difference between the indices of absorption of the upper and lower halves of the liquid. These two indices of absorption are determined by direct measurement. $\frac{1}{3}\Delta$ is in no case larger than 1 or 2 per cent.

OXYHEMOGLOBIN

A large part of the action of the radiation on a solution of oxyhemoglobin consists in a transformation of the oxyhemoglobin to methemoglobin, although, as far as we can judge from the spectrum, this is not the only reaction which takes place. The hemoglobin solution is prepared as follows: A few cubic centimeters of blood are taken from the heart of a rabbit and are defibrinated; the corpuscles are separated from the serum by centrifugalization and are washed once with Ringer's solution. The mass of concentrated corpuscles is hemolyzed by adding 15 c.c. of distilled water for each cubic centimeter of the original amount of blood, making a solution approximately $\frac{1}{2}\ 10^{-3}$n in respect to hemoglobin, if we take the molecular weight of hemoglobin to be 16,700. This solution is centrifuged to free it of any precipitate which may be present, and it is then irradiated. The dose necessary to transform 50 per cent of the hemoglobin of this solution is about 56,000 Roentgen.

The amount of oxyhemoglobin is measured with a spectrophotometer, the photometer being of the Martens type. The irradiated solution is diluted with Ringer's solution in the ratio of 0.85 c.c. to 25c.c.; a photometer cell filled with this diluted solution is placed in the path of one of the two beams of light of the photometer and the photometric fields are adjusted to equality of brightness for $\lambda = 5420$ Å and also for $\lambda = 5150$ Å; $\lambda = 5420$ Å is the center of one of the two strong oxyhemoglobin bands; $\lambda = 5150$ Å is outside this band but as close to it as we can go. If the angular settings are called ϑ_1 and ϑ_2, the relative content of hemoglobin can be expressed by

$$\text{Hb} = \log_e \frac{\text{tg}^2\vartheta_1}{\text{tg}^2\vartheta_2} \sim \log_e \frac{\text{tg}\vartheta_1}{\text{tg}\vartheta_2}$$

The exactness of this expression is of no

real importance to us, since we are interested only in establishing equalities of the hemoglobin content of different samples. The expression, however, is undoubtedly quite accurate, the values obtained by it for the hemoglobin content of solutions made from our standard hemoglobin solution by dilution with Ringer's solution being in good agreement with the dilution factors, and the substances formed by the irradiation of the hemoglobin solution showing no difference in absorption at 5420 Å and 5150 Å, as far as we can judge by observing the spectrum of a solution which has been irradiated with such a strong dose that practically all the hemoglobin is transformed.

The methemoglobin (or other substances) formed by the irradiation has a broad band of absorption at the part of the spectrum where we are working. Therefore the result of the irradiation is an opposite change in the two angles ϑ_1 and ϑ_2, ϑ_1 increasing while ϑ_2 decreases. During the course of the investigation we have frequently kept control cells under lead close to the irradiated cells; we have, however, never found these samples to be affected.

As we shall see, a high accuracy can be obtained in these measurements if the influence of certain effects which we shall now mention is properly eliminated:

1. If the unirradiated hemoglobin solution is kept at room temperature, certain changes take place in it, as the result of which the action of a subsequent irradiation is greatly increased. The reason for this has not been investigated. There is no change in the oxyhemoglobin itself during the process, as far as one can judge from the spectrophotometer. The effect may be due to a transformation of some of the proteins in the solution, the presence of which very strongly inhibits the action of the rays on the hemoglobin. This process is very much slower if the solution is kept at a low temperature in an ice box and it apparently stops completely if the solution is frozen.

2. When the irradiation of a sample of the hemoglobin solution is discontinued, certain very slow processes continue to go on, as shown by slight changes in the course of an hour in the absorption at both 5420 Å and 5150 Å. The resultant change in the oxyhemoglobin content is small. The process seems to consist mainly in a further transformation of the substances primarily formed by the action of the rays on the hemoglobin.

3. When the irradiated sample is diluted for the purpose of measuring it in the spectrophotometer there is induced a quite rapid process which is noticeable in the course of five or ten minutes and continues for hours. This process may be considered as a continuation of the irradiation process, the hemoglobin content diminishing and the changes in the spectrophotometer readings at 5420 Å and 5150 Å being in opposite directions and in about the same ratio as those produced by increasing radiation.

To avoid error due to these effects, we have adopted the following technique: The hemoglobin solution is kept frozen (at $-20°$C.) in a number of test glasses, each of which contains enough of the solution to fill one cell. Two cells are under investigation at the same time, being irradiated alternately, one with one radiation, the other with one of the other two radiations. The total time of exposure for one cell is usually about 100 minutes, each cell being irradiated four times for about twenty-five minutes each. All operations and measurements with these cells are made in as identical a manner as possible and follow a fixed time schedule, twenty-five minutes elapsing between corresponding operations. During irradiation the cells are kept at a temperature of about 16°C., in the intervals between irradiations they are kept near zero in an ice box. For control, two samples are taken from each irradiated cell, these being measured in the spectrophotometer at an interval of one hour.

In a few series of experiments we have determined the effect of varying the dose, this being done by varying the current through the tube, while keeping the time of exposure approximately constant. The result of one such series is recorded in Figure 4, in which the points x represent the measurements. These points lie very closely on an exponential curve (fully drawn) [$\%$ Hb $= 100e^{-\alpha \cdot \text{Dose}}$] which means that under our experimental conditions the decrease in the hemoglobin con-

centration is proportional to the amount of hemoglobin present. As already discussed in the introduction, this is not a general rule, but must be explained by conditions which are peculiar to our hemoglobin solution. It is interesting that Hussey and Thompson[7,8,9] find this logarithmic law to hold quite accurately also for a number of

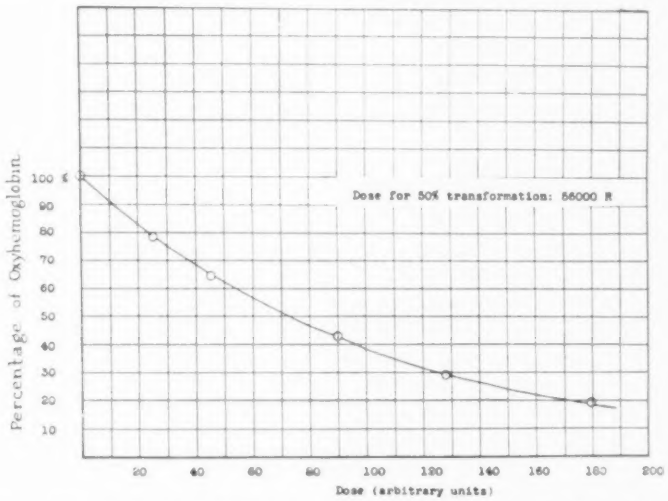

FIG. 4. The action of different doses of roentgen rays on oxyhemoglobin.

different enzymes which they have investigated.* The explanation may perhaps be that the substances which are formed by the action of the rays on the original substances are themselves still further transformed by the rays. If we assume that the total number of reacting molecules remains constant, that fraction of the energy of the rays which is used to transform the original substances must at any time be proportional to their concentration.

The first experiments to be recorded have been made on the hemoglobin solution prepared as described above; the salt content of this solution is so low that its effective atomic number is practically equal to that of pure water, 7.43. For the sake of a control, experiments have been made with both the glass cell and the paraffin cell. In one set of experiments, radiations I and II were compared; in another, radiations II and III. The results of all our experiments are given in Tables II and III. The "ratio of effects" in the last column means the ratio of such doses as give equal effects on the hemoglobin solution. By means of the curve in Figure 4 is determined the ratio of the doses, which correspond to the effects given in columns 2 and 3. This ratio, divided by the ratio of the doses actually applied which is recorded in column 1, gives the "ratio of effects."

TABLE II

OXYHEMOGLOBIN IN WATER

Comparison of Radiations I (λ: 248 Å) and II (λ: 0.527 Å)

Ratio of Doses (I/II)	Concentration of Hemoglobin in Per Cents of Original Concentration after Irradiation with		Ratio of Effects (I/II)	
	I	II		
1.080	Per Cent 49.35	Per Cent 53.0	1.03	
1.085	46.0	49.6	1.025	Paraffin cell
0.980	53.1	53.1	1.02	Average: 1.01 ± 2%
1.025	50.1	51.5	1.015	
0.995	50.7	49.5	0.97	
1.10	53.0	56.9	1.025	
1.01	56.8	56.8	0.99	Glass cell
0.99	59.6	59.9	1.02	Average: 1.01 ± 1%

No difference is found between the paraffin cell and the glass cell. In investigations of some chemical reactions we have had to use a glass cell because paraffin or other materials which might otherwise come in question are attacked by, or

* We may here mention that Hussey and Thompson[7] (compare also Clark and Northrop,[10]) having noted that the percentile effect of roentgen rays on a concentrated solution of trypsin is much lower than it is on a diluted solution, from this fact draw the conclusion that roentgen rays do not act on combined trypsin. Evidently this conclusion is not warranted; this comparatively small effect on the concentrated solution is a general rule, intrinsic in the mechanism of the reaction, as discussed in the introduction of this report.

interact in some way with the action of the rays on the solutions. It seemed possible that an error might be induced when using a glass cell with a very thin layer of liquid, because of the secondary electrons from the glass. Our experiments show that this effect is inappreciable in the glass cell we have used here.

TABLE III

OXYHEMOGLOBIN IN WATER
Comparisons of Radiations
II(λ:0.527 Å) and III (λ:0.754 Å.)

Ratio of Doses (II/III)	Concentration of Hemoglobin in Per Cents of Original Concentration after Irradiation with		Ratio of Effects (II/III)	
	II	III		
	Per Cent	Per Cent		
0.990	59.5	59.2	1.00	
1.005	51.7	52.1	1.005	Paraffin cell
0.990	54.6	55.0	0.980	Average: 1.00 ± 1%
1.000	53.3	52.9	0.995	
1.010	57.4	56.8	0.97	
0.995	56.2	57.8	1.05	Glass cell
0.995	61.8	61.0	0.98	Average: 1.00 ± 2%
0.990	54.3	54.5	1.015	

TABLE IV

OXYHEMOGLOBIN IN 16.8 PER CENT SOLUTION OF POTASSIUM CHLORID IN WATER
Comparisons of Radiations
I(λ:0.248 Å) and II (λ:0.527 Å)

Ratio of Doses (I/II)	Concentration of Hemoglobin in Per Cents of Original Concentration after Irradiation with		Ratio of Effects (I/II)	
	I	II		
	Per Cent	Per Cent		
1.15	16.3	15.1	0.837	Average: 0.825 ± 1%
1.29	46.0	48.0	0.823	
1.25	47.8	48.7	0.820	

TABLE V

OXYHEMOGLOBIN IN 16.8 PER CENT SOLUTION OF POTASSIUM CHLORID IN WATER
Comparison of Radiations
II(λ:0.527 Å) and III(λ:0.754 Å)

Ratio of Doses (II/III)	Concentration of Oxyhemoglobin in Per Cents of Original Concentration after Irradiation with		Ratio of Effects (II/III)	
	II	III		
	Per Cent	Per Cent		
0.985	48.4	47.3	0.985	
1.06	51.35	54.75	1.04	Average: 1.01 ± 2%
0.995	50.1	50.5	1.015	

We conclude from our experiments that the radiations λ = 0.75 Å and λ = 0.54 Å have the same effect, while the radiation λ = 0.248 Å has 1 or 2 per cent more effect than the radiation λ = 0.54 Å. This slightly greater effect of the hardest radiation, although hardly outside the limit of our experimental accuracy, is undoubtedly real. Its magnitude is about what would be expected, because the effective atomic number of water is a little lower than that of air (7.42 as compared with 7.66).

In the introduction we have shown that on account of the Compton effect we should expect the action of hard rays on a solution with an effective number larger than that of air to be comparatively too low. The results of a series of experiments demonstrating that this is the case are given in Tables IV and V. In these experiments we have irradiated oxyhemoglobin in a 16.8 per cent solution of potassium chlorid in water. The glass cell was used. While the effects of radiations II and III are the same within our experimental accuracy (radiation II should theoretically have about 1 per cent less effect than radiation III), the effect of rabiation I is 21 per cent lower than the effect of radiation II. As a calculation shows, this is in a satisfactory agreement with Compton's theory.

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THE SKIN ERYTHEMA DOSE WITH A COMBINATION OF TWO TYPES OF RADIATION

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THE skin erythema dose is generally used as an indicator of the quantity of radiation used at a given exposure, regardless of its quality. Several authors have pointed out the inaccuracy of the erythema dose as a standard because of the variability in the definitions of erythema.[1,2,3,4] In our erythema measurements at the Memorial Hospital we have avoided this difficulty by using the threshold erythema.[5,6] However, there still remains the uncertainty due to the effect of the quality of the radiation on the production of the erythema. This has been discussed by a number of workers, who have compared the erythema and ionization doses for roentgen rays over a large range of wave lengths.[2,7,8] Glasser and Meyer, for instance, have shown that as the effective wave length decreases (more filter or higher voltage) the number of ionization units required to produce an erythema increases in the same ratio as the half-value thickness in centimeters of water (the thickness of water required to reduce the intensity of the radiation by 50 per cent).

The work here reported was planned to determine the effect, as regards the skin dose, of combining two types of radium radiation ("soft" and "hard" rays) in a single treatment. It has sometimes been stated that an erythema dose of gamma rays can be followed immediately by a full dose of roentgen rays without producing an excessive skin reaction. Of course the definition of excessive may here be called in question, certainly the reaction is more intense. However, the reaction to the combined radiation should be investigated. The problem naturally resolves itself into two parts: (1) Does irradiation with half an erythema dose of one type of radiation followed immediately by half a dose of another type, produce the same skin reaction as a full dose of either? (2) If it does not, what change in the doses given is necessary to produce the same effect?

Two types of radium radiations were used for these investigations, one consisting predominantly of beta rays, the other practically all gamma rays.

The method of making our skin erythema tests has been described in previous publications from this laboratory;[5,6] it will suffice here to recapitulate briefly. The method of applying the radium radiation is indicated in Figure 1. The source of radiation is a glass capillary tube 14 milli-

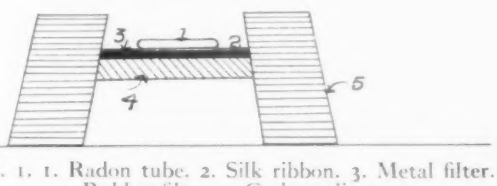

FIG. 1. 1. Radon tube. 2. Silk ribbon. 3. Metal filter. 4. Rubber filter. 5. Cork applicator.

meters long, containing radon. Filters to regulate the quality of radiation reaching the skin are inserted below the tube, and the applicator is strapped to the skin of the patient with adhesive tape. The erythema dose for any particular type of radiation is determined by testing a number of individuals with different exposures, until doses are found which give a slight reaction in some cases, but no visible effect in others.* After results have been obtained for several different millicurie-hour doses, a curve is plotted and the dose determined for which 80 per cent of the cases tested would show an erythema. This is our so-called "threshold erythema dose;" its use does not require recognition of a definite intensity of reddening, but simply the observation of whether or not there is any reaction.

The two types of radiation used were one which was predominantly beta and

* The effect observed is not the transient primary reddening, which takes place a few hours after irradiation, but the secondary effect, which appears from two to three weeks later and persists for several weeks or months.

one which was practically all gamma. For the first or "soft" type, the filter was 0.16 mm. of brass and 1.2 mm. of rubber. This, of course, removes the very soft beta rays. The unscreened glass tube would have provided softer radiation, but small differences in the wall thicknesses of the tubes used from day to day would cause large variations in the amount of the very soft radiation transmitted. These variations would lead to inconsistent results in the tests. Therefore it was considered advisable to eliminate this extremely soft radiation. The filter used does this, thus rendering the radiation tested more uniform, and still leaving it predominantly beta in type (67 per cent beta, 33 per cent gamma). For the second, or "hard" type, the filter was 0.5 mm. of silver, 1 mm. of brass, and 2.4 mm. of rubber, which is our standard gamma-ray filter.

With the standard applicator so arranged that the center of the radon tube was 1 cm. from the skin, the threshold erythema doses were experimentally determined, for the thin filter 16 millicurie-hours, for the thicker one, 290 mc-hr. Now if 8 mc-hr. were given with the first, followed immediately over the same area by 145 mc-hr. with the second, no erythema appeared. The doses for each were increased gradually, a number of patients being tested with each combination; the threshold erythema dose was found to be 10.5 mc-hr. for the soft, added to 190 for the hard. That is, instead of the summation of half a dose of each kind producing an erythema, two-thirds of a dose of each kind was necessary to produce the same effect as one dose of either. Table 1 shows the actual tests made to arrive at this conclusion.

TABLE 1

Dose Mc-hr.	Erythema Appeared	No Erythema Appeared
	Soft Radiation	
12	0	4
14	6	8
16	14	4
18	11	1
	Hard Radiation	
275	1	4
290	9	2
310	6	0
	Combined Radiation	
8 145	2	7
9 170	3	3
10.5 195	13	4
12 200	8	0

The question then arose as to why this should be so. Evidently the skin will absorb more energy before visible changes occur, if this energy is not all of the same type. But if we consider where this absorption of energy takes place, we may find a possible explanation. The softer radiation, being much less penetrating, is absorbed largely in the first few millimeters of tissue, while the harder radiation is effective to a greater depth. The facts regarding this may be seen from Table II.

Two factors determine the amount of radiation reaching any given tissue depth, the distance from the source and the absorption taking place in the tissue already traversed. The effect of distance is the same for all types of radiation, for point sources the intensity decreases as the square of the distance increases (the well-known "inverse square law"). This decrease is shown in column 3. For a tube the change would not be quite so rapid; the correction has not been made here because with tubes at the same distance the factor would be practically the same in any case. However the change in absorption with the type of radiation is very great. The absorption of the type of soft radiation used in these experiments is shown in column 4, and of the hard radiation in column 6. These values are taken from work previously published from this laboratory[9] and represent the transmitted radiation in percentages of the incident radiation. It will be seen that 26 per cent of the soft radiation has been absorbed in the first millimeter of tissue and 45 per cent in the first two millimeters. Only 22 per cent penetrates to the end of the first centimeter. On the other hand, only 6 per cent of the harder radiation is absorbed in the first centimeter. The combined effects of distance and absorption are shown in columns 5 and 7. From these it is

TABLE II

1	2	3	4	5	6	7
			Soft Type		Hard Type	
Tissue Depth, Mm.	Dis. from Ra., Mm.	Per Cent Decrease Due to Distance	Per Cent Decrease Due to Absorption	Final Per Cent	Per Cent Decrease Due to Absorption	Final Per Cent
0	10	100	100	100	100	100
1	11	83	74	62	99	82
2	12	70	55	39	98	69
3	13	59	44	27	97	57
5	15	44	31	14	96	42
7	17	33	26	8.5	95	31
10	20	25	22	5.5	94	24

TABLE III

1	2	3	4	5	6	7	8	9	10	11
	Soft Radiation—4 Cm. Distance					Hard Radiation—0.5 Cm. Distance				
Tissue Depth, Mm.	Dis. from Ra	Inv. Square Per Cent	Abs. Per Cent	Tube Length Factor	Final Per Cent	Dis. from Ra	Inv. Square Per Cent	Abs. Per Cent	Tube Length Factor	Final Per Cent
0	40	100	100	100	100	5	100	100	100	100
1	41	95	74	100	70	6	70	99	109	75
2	42	91	55	101	51	7	51	98	115	57
3	43	87	44	101	39	8	39	97	121	46
5	45	79	31	101	25	10	25	96	128	30
7	47	73	26	102	19	13	15	95	134	19
10	50	64	22	102	14	15	11	94	137	14

seen that whereas 24 per cent of the hard rays pass entirely through the first centimeter of tissue, the soft rays are reduced to almost this same intensity—27 per cent—in 3 millimeters.*

Since there is such a difference in the distribution of the radiation in the two cases, it seems possible that this has an effect on the production of the erythema. The tissue being affected is not the same in each case, and this may account for the observed difference. In order to make an accurate comparison, it is necessary to arrange conditions so that the distribution of the two types of radiation shall be essentially the same in the irradiated tissue.

This can be done by changing the distances of the radioactive sources from the skin. For, the shorter the distance, the more rapidly the radiation falls off according to the inverse square law. Therefore, by putting the source of hard rays closer to the skin and that of the soft ones farther away, it should be possible to find positions such that the products of the distance and absorption factors would be nearly equal for the two types of radiation. The correction for the fact that we are dealing with tubes and not point sources should also be included, since it becomes important for very short distances.

It was found that if the source of hard rays were put 0.5 cm. from the skin, and that of the soft rays 4 cm. away, the distribution of the two types was substantially the same. This may be seen from Table III. With this arrangement the

* No allowance has been made for the scattering of the radiation by the tissue. It will be shown later that this does not need to be considered in this problem.

same percentage of each type of radiation is absorbed in the first centimeter of tissue. While the distribution throughout this centimeter is not identical, the two are now comparable.

The skin doses for these applicators, determined experimentally are: for the lightly filtered tube at 4 cm., 115 mc-hr., and for the heavily filtered tube at 0.5 cm., 64 mc-hr. Now, the quantity of radiation being the same, if the erythema is independent of the quality of the radiation, half a dose from the first, followed immediately by half a dose from the second, should produce the standard reaction. However, this was found not to be so. The threshold erythema dose for the combined radiation was 75 mc-hr. from the first and 43 mc-hr. from the second. That is, even with the applicators so arranged that the distribution of the radiation in the tissue is nearly the same for both types of radiation, it is still necessary to use two-thirds of a dose of each to produce an erythema. Incidentally it is of interest to note that it makes no difference which type of radiation is applied first, the results are the same in either case. The results of the actual tests are shown in Table IV.

TABLE IV

Dose Mc-hr.	Erythema Appeared	No Erythema Appeared
Soft Radiation (4 cm.)		
110	10	8
115	13	3
120	15	1
Hard Radiation (0.5 cm.)		
60	6	8
65	8	1
70	4	0
Combined Radiation		
32.5 57.5	1	6
36 64	9	13
42 72	22	8

The explanation of this phenomenon cannot be the effect of scattered radiation. The relative distances of the two applicators are varied from being the same to one being eight times the other. By such a considerable change in distance the distribution of the radiation in the tissue is changed very materially. For example, when the distances are the same (1 cm.), there is 111 per cent more radiation delivered to a depth of 3 mm. by the heavily filtered applicator than by the other. When the heavily filtered applicator is used at one-eighth the distance of the other (0.5 cm. and 4 cm.), it delivers only 18 per cent more at a depth of 3 mm. Now the scattered radiation present must be in the same ratio as the primary radiation producing it. The change in distances produces a large change in the relative amounts of primary, and hence of secondary, radiation. Yet the observed relation between percentage of combined radiation and erythema effect remains the same.

It seems probable that the explanation of the observed fact must lie in the difference in the quality of the radiation, rather than in its distribution. Whether the different types affect different cells, or different parts of the same cell, to greater or less extent, or whether the explanation is in some other physiological condition, is a question for the biologist rather than the physicist.

The *conclusions* to be drawn from these observations may be stated as follows:

1. The formation of a skin erythema is determined not only by the quantity, but also by the quality of the radiation absorbed.

2. If radiation dose be measured by erythema effect, two-thirds of a dose of soft radium radiation must be immediately followed by two-thirds of a dose of hard radiation, or vice versa, in order to produce the same erythema as one full dose of either.

3. It is probable that the different types of radiation either affect different cells, or different parts of the same cells to different extents.

The writer wishes to acknowledge her indebtedness to Dr. Failla for his suggestion of the problem, and advice as to the methods of attack. She also wishes to thank the radium technicians who have prepared the applicators for these tests, and the members of the house staff, who have assisted in making them, over a period of many months.

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"DIABETIC TUBERCULOSIS"*

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THE subject of diabetes is one rarely brought before roentgenologists for discussion. It is presented here on account of the importance of the roentgen ray in discovering one of the serious complications of diabetes, pulmonary tuberculosis.

This study was begun in 1923 following the appearance of several diabetic patients with a florid hilum type of tuberculosis which gave little or no physical signs. In an attempt to determine the frequency of pulmonary tuberculosis in diabetics, all patients with diabetes admitted to the medical wards of this hospital had a routine roentgen examination of the chest made, and the examination was repeated as many times as thought advisable. This report is based on the observations made on 182 consecutive cases admitted during the past three years, 261 separate examinations being made by our department.

In an attempt to obtain an average figure as to the incidence of pulmonary tuberculosis in the population at large and its frequency as a cause of death in adults, we encountered the widest variation in opinions and estimates. Agreement was close as to the matter of *infection*, it being almost universally conceded that about 90 per cent of adults are, or have been, infected. In the matter of morbidity and mortality, however, the observers are no longer agreed. Osler[1] gives tuberculosis as the cause of death in the United States in 10 per cent of cases. Baldwin[2] states that one-third of all the deaths between the

FIG. 1. A. Typical "healed" apical tuberculosis. B. Typical adult apical tuberculosis. C. Hilum or unsensitized type of tuberculosis occurring in diabetics.

* From the Department of Roentgenology, Peter Bent Brigham Hospital; Read at the Twenty-seventh Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Detroit, Mich., May 17–21, 1926.

ages of fifteen and forty-five are due to tuberculosis. Adami and McCrae[3] found active tuberculosis in 17.3 per cent of 1000 autopsies (hospital cases). Joslin[4] gives 3.1 per cent as the incidence of pulmonary tuberculosis in 1146 cases of diabetes, while his figures on fatal cases show pulmonary tuberculosis as the cause of death in 6.0 per cent. This is in close accord with the prevalence of tuberculosis in this state, the figures for 1921 showing that 6.9 per cent of the total deaths were due to pulmonary tuberculosis. Krause[5] states that the morbidity averages ten times the mortality in the general population, the former estimated at 1.5 per cent and the latter 0.15 per cent.

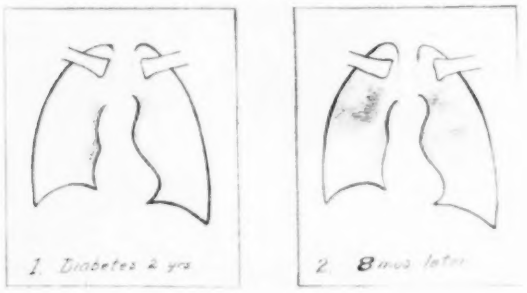

FIG. 2.

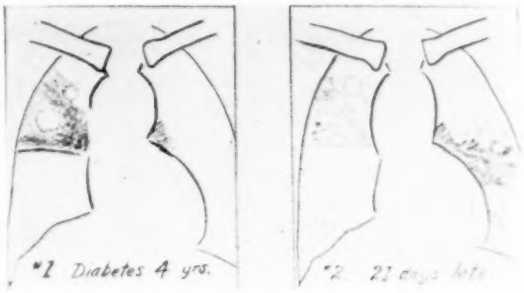

FIG. 3.

It is surprising to see that our figures are considerably higher than the normal expectancy. In 1074 cases of diabetes studied in this hospital, a clinical diagnosis of pulmonary tuberculosis was made in 3.0 per cent, while in the 182 patients admitted during the past three years, nearly all of whom had routine roentgen examination of the chest, the percentage was nine.* Futhermore, in 37 autopsied cases reported by Fitz and Murphy[7] from this hospital, pulmonary tuberculosis was found *as a cause of death* in 19 per cent.

Two explanations of this paradox may be offered: (*a*) that pulmonary tuberculosis frequently goes unrecognized in persons suffering from diabetes, probably because the symptoms are often mild in comparison with the extent of the disease, and because they may be attributed to the diabetes without a search for other cause, or because the tuberculosis is hard to recognize on account of its location deep in the lung; (*b*) that an acute pulmonary tuberculosis is frequently superimposed upon the diabetes as a terminal infection, as may happen in any chronic wasting disease.

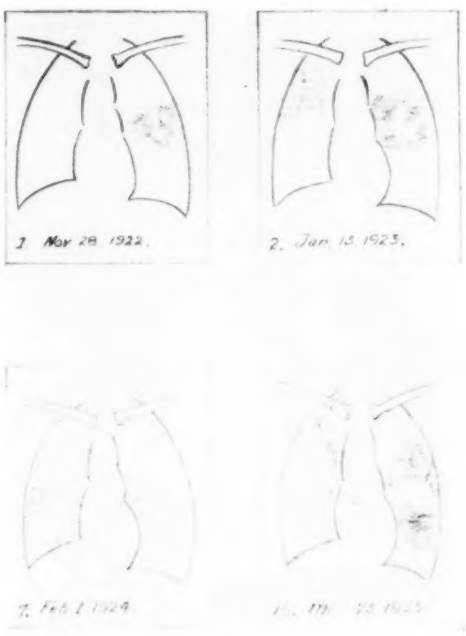

FIG. 4.

FIGS. 2, 3 and 4. Illustrating the development and spread of pulmonary tuberculosis in diabetics, in spite of rest, diet and insulin.

There are three other points of interest which have developed during this study:

(*a*) *The Type of Tuberculosis.* In the 182 patients with diabetes there were found 11 cases of old "healed" apical tuberculous lesions, the fibrosis and calcification being

* As a check on the accuracy of the diagnosis by roentgenography, Monroe and Emery[6] report our findings in confirmed cases (positive sputum) to be correct in 97 per cent of the 500 cases examined.

such as would probably take years to produce (Fig. 1A.). These 11 cases are *not* included in the incidence of 9 per cent given above. There were in addition 17 cases of "recent" pulmonary tuberculosis, of the bronchopneumonic type, usually around the hila and deep in the lungs, strongly suggesting the type of tuberculosis seen in children or in unsensitized persons (Figs. 1C, 2, 3 and 4). This was found, however, in individuals well above the average age of such a form of tuberculosis, all but 3 of the patients being over forty-five years of age. This hilum form of tuberculosis, occurring in persons over forty-five years of age who also have diabetes, has been given the name of "diabetic tuberculosis" unofficially in this hospital, simply as a short descriptive term or handle for everyday use.

If we consider the "healed" apical lesion as Type I (Fig. 1A), the ordinary "adult" apical form as Type II (Fig. 1B) and the "hilum" or unsensitized tuberculosis as Type III (Figs. 1C, 2, 3 and 4), we have the following frequencies in 45 cases with pulmonary tuberculosis complicating diabetes:

Type I	16 cases
Type II	8 cases
Type III	21 cases

These include all of our cases of pulmonary tuberculosis coexistent with diabetes, of which 11 of Type I and 17 of Type III were found during the three years of routine chest examinations. The average age of the 21 Type III cases was fifty-one years at the time of examination. These figures show a decided inversion of the usual frequency, in that Types I and II ordinarily include 95 to 97 per cent of consecutive and unselected cases of pulmonary tuberculosis.

(*b*) *Mode of Infection.* The fact that a certain number of apical tuberculous lesions remained unchanged during several years of diabetes (only one patient out of 16 developed active tuberculosis) is against a theory of re-activation of an old focus by the change in nutrition incident to diabetes, and the "young" type of reaction in the other cases suggests that there has been a new infection; "seeds sown in unusually fertile ground," perhaps, but not a flaring up of an old lesion.

(*c*) *Incidental Findings.* In addition to the findings noted above, there were 7 doubtful cases, i.e., with appearances suggesting the possibility of an early tuberculosis, but not included in the percentages because of lack of confirmation or of re-examination, 4 cases of lobar pneumonia, 2 of bronchopneumonia, and one of empyema. Calcification in the arch of the aorta was noted frequently, but as the films were not made with this in mind, no attempt was made to estimate its frequency.

In our series of cases the *prognosis* has been uniformly bad; all of the patients who developed tuberculosis are known to be dead except one, and he has disappeared. However, Sansum,[8] Montgomery,[9] Hart and Creel,[10] and Janney and Newell[11] report good results, with improvement in both diseases, especially since insulin has come into use. We have also failed to note any beneficial effect upon the carbohydrate tolerance as the tuberculosis advances, a finding noted by Joslin[4] and others.

SUMMARY

1. Pulmonary tuberculosis was found complicating diabetes in 9 per cent of 182 patients who had routine roentgen-ray examinations of the chest.

2. The pulmonary tuberculosis was frequently of the hilum or unsensitized form, 46 per cent of 45 cases, and occurred most frequently in patients past forty-five years of age.

3. The prognosis was uniformly poor, even with insulin.

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DISCUSSION

Dr. J. Burns Amberson, Jr., Northville, Mich. Tuberculosis in diabetics, as Dr. Sosman has described, is, I think, just as he says, an exudative, rapidly caseating type, such as we see occurring typically in non-immune individuals, especially children. We see it also in non-tuberculized adults, for example, in some negroes and in certain uncivilized tribes. That was shown especially during the World War.

Dr. Ross Golden, New York City. For the past eight years it has been the custom at the Presbyterian Hospital, New York, to have a roentgen-ray examination of the chest of every diabetic. I asked the clinicians why that routine was begun. They said they believed it was due not to increased difficulty in the detection of pulmonary tuberculosis clinically in the diabetic as compared with the usual case but to its increased importance. Dr. Sosman's studies, however, seem to indicate that it may well be more difficult to detect on routine physical examination because it more frequently develops from the hilum.

Investigation of our records discloses figures quite different from those mentioned by Dr. Sosman. During the decade from 1916 to 1925, 1,091 cases of diabetes were admitted to the hospital and a diagnosis of pulmonary tuberculosis was made in 57, or a little over 5 per cent.

In the Department of Pathology, from 1908 to 1925 there were 53 necropsies upon diabetics. Pulmonary tuberculosis was found in 14 of them and was given as the cause of death in only three. This is an incidence of 26 per cent and the cause of death in 6 per cent—if one may speak of percentage with such a small series of cases. The total number of necropsies done during the same period was 1,097, among which were 270 cases of pulmonary tuberculosis, an incidence of 13 per cent. In other words, even in this small series tuberculosis was found twice as often in diabetics as in unselected cases.

Such findings, however, must be interpreted in the light of a knowledge of the individual hospital. It is a custom at the Presbyterian Hospital to avoid admitting and keeping cases of tuberculosis whenever possible. Consequently, as soon as tuberculosis is found, unless the patient is in need of active hospital treatment for diabetes, he is sent to some other institution. That is probably one reason, at least, why our figures are so different from those of the Peter Bent Brigham Hospital and those in the literature as summarized in Dr. Sosman's very interesting paper.

It would seem that no symposium on pulmonary tuberculosis is complete without mentioning the very important experimental work of Allen K. Krause, in which he showed the rôle of the lymphatic structures of the lung in the development of the disease. This was excellently summarized in his Harvey Lecture given in the spring of 1922. All of us who have to do with the detection of this condition by roentgen-ray examinaton ought to be familiar with it.

Dr. Frank S. Bissell, Minneapolis, Minn. Dr. Sosman shows a definite type of tuberculosis, but it doesn't differ essentially from other types of adult tuberculosis as far as I can see.

We observe a bizarre group of pulmonary changes of different types, due to tuberculosis, but they all conform to certain specific laws. His question of why men overlook these changes under certain conditions is easily answered. A man who is studying a case from the standpoint of diabetes makes his diagnosis and is interested in the diabetes; he is not interested in anything else. I can illustrate the point by citing an incident which occurred in our hospital, a very good hospital with a very excellent staff. A patient with a diagnosis of cerebellar tumor was in the ward many months. Everybody was intensely interested in it and its manifestations. Many neurologists and brain surgeons in the vicinity were called in to see this case as a matter of interest, but no one thought of having the chest x-rayed or examined. The man died of pulmonary tuberculosis. He did not die of the brain tumor, which he did have, as was shown by autopsy. It simply shows that where one diagnosis is made, other possible diagnoses are likely to be ignored or forgotten.

Dr. R. G. Allison, Minneapolis, Minn. I was extremely interested in Dr. Sosman's series of cases of tuberculosis occurring in diabetics. I have seen quite a number of those in the last few years. Almost invariably we have had the typical picture of tuberculosis in the unsensitized animal. The process has spread with the greatest rapidity and it has been very striking to see several of those cases that were unilateral subjected to insulin and dietetic therapy and artificial pneumothorax instituted at the same time. Some of the most marvelous cures I have seen in tuberculosis have occurred in these diabetics with rapidly spreading pneumonic tuberculosis.

Dr. Sosman (closing). I think Dr. Golden's report makes evident the difficulty we have in trying to estimate the percentage of tuberculosis in any given group. Various authors estimate that it is anywhere from 1 to 17 per cent in the normal population, and with those figures we can't accurately say that one is above normal or that the other is below normal. I think he has confirmed that nicely.

We must also differentiate between the incidence of pulmonary tuberculosis (morbidity) and the mortality due to pulmonary tuberculosis.

My main purpose in this paper was simply to put these cases and figures on record and to see if there was a similar incidence and mortality in other places.

Dr. Bissell said that the basal type was still pulmonary tuberculosis and not unusual, if I understood him correctly, but it has been our experience that it occurs only in about 1 per cent of all the tuberculosis we see. Dr. Allison said 5 per cent, and those were all confirmed cases of pulmonary tuberculosis, not pneumonias. The basal or hilum type was so frequent in diabetics that I believe it is a particular lesion influenced by the diabetic factor in some way. Our difficulty is that we do not take cases of pulmonary tuberculosis in our hospital; they are on a similar status in the Presbyterian Hospital and the ordinary sanatorium gets very few diabetics. The result is that our men know little about the treatment of tuberculosis and the men in the sanatoriums know little about the treatment of diabetes. If they stay with us, they die of tuberculosis; if they go to the sanatorium, they cure the tuberculosis but they die of diabetes. We are between two fires. We ought to have a special sanatorium some place for these cases.

Dr. Bissell. I was commenting upon your drawings of your cases and it seemed to me that they were not true cases of basal tuberculosis but that there was in the upper part of the lung some tuberculosis, at least the middle part of the lung.

Dr. Sosman. I started the series with the normal adult tuberculosis and then went through to the basal lesion and told you that the basal lesion was the common type. In fact, they were practically all the basal type of lesion in this series.

I think all diabetics should have the chest x-rayed routinely, particularly if they are doing badly, and Dr. Bissell explained the necessity for that, I believe, very well. If a diagnosis of diabetes is made and the patient loses weight and is not doing well, it is thought to be due to the diabetes and the chest is not gone over as carefully as it would be otherwise.

THE SAUCER DEFORMITY OF THE DIAPHRAGM WITH AN INQUIRY INTO ITS ORIGIN*

BY WILLIAM S. MIDDLETON, M.D.

MADISON, WISCONSIN

A COMPREHENSIVE dissertation on subdiaphragmatic abscess by Lockwood[1] in 1921, included the following description of the roentgen findings: "In early cases, or in extraperitoneal abscess, or in the right posterior intraperitoneal abscess, the diaphragm may be only slightly elevated, but may show a fairly characteristic irregularity. On the other hand, the diaphragm may be as high as the third or fourth space and absolutely regular in outline. In the usual picture the diaphragm is raised to the fourth space, and shows some cupping. The lung is not collapsed, but is merely pushed up. The outline of the diaphragm is more uniform than in cases in which the diaphragm is elevated by an abscess of the liver. The line of the diaphragm is more irregular when it has been caught up by an old pleuritis or by a partial collapse of the lung. Gas can usually be discovered by the roentgenogram, and gas and fluid by the fluoroscope. With fluid in the pleural cavity the diaphragm is usually low; it is irregularly high from an early pleuritis, and the fluid is a later development. In such cases, however, the costophrenic angle is generally blotted out, whereas in subphrenic abscess one or both angles are often clear." The description of cupping of the elevated diaphragm in subphrenic abscess is generally subscribed to. More recent studies, such as those of Martin,[2] include this unusual cupping of the dome among the phrenic deformities dependent on subdiaphragmatic abscess.

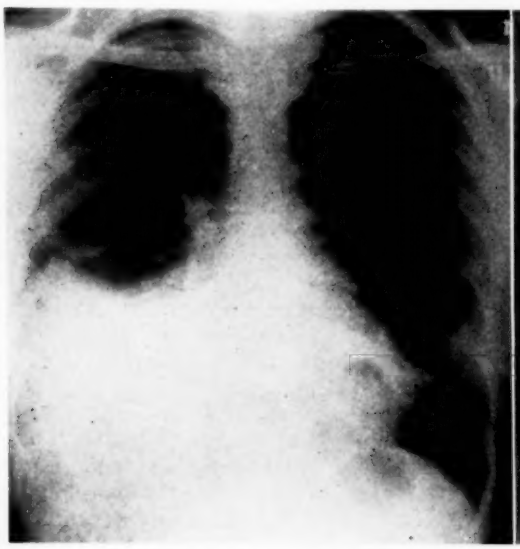

FIG. 1. Roentgenogram of Case I.

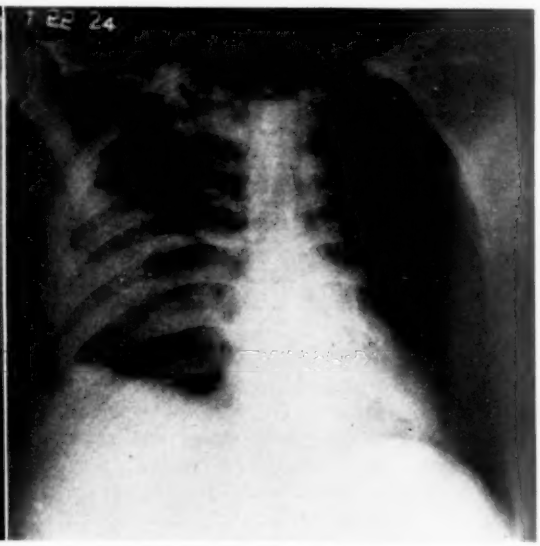

FIG. 2. Roentgenogram of Case II.*

In the following case an egregious error resulted from the assumption that such cupping resulted only from subdiaphragmatic abscess:

CASE I. C. McF., aged thirty-three, white female, was admitted to the Bradley Memorial Hospital complaining of pain in the right chest. A history of indigestion with belching of gas over a period of three years was elicited. Typical pleuritic pain with dyspnea had supervened in the past month. The remainder of the history was irrelevant in the present relation.

*Dr. Lawrence Littig, Madison, kindly loaned the negative from which the print for this figure was taken.

* From the Department of Medicine, University of Wisconsin.

From physical examination there were determined suggestive evidences of a fluid accumulation with an overlying friction rub at the right base, but stereoscopic roentgenograms showed a classical cupped deformity of the elevated diaphragm and it was thought that a zone of decreased density could be visualized somewhat below the peaked diaphragm (Fig. 1). Roentgenoscopy of the stomach showed no filling defect nor deformity suggestive of ulcer. Slight inspiratory depression of the concavity replacing the normal dome of the right diaphragm constituted the sole motility of this muscle to roentgenoscopic observation. The pleuritic friction was later supplanted by unequivocal signs of fluid. Suspecting a pleurisy with effusion secondary to a subphrenic abscess, the former (a serofibrinous exudate) was drained through an intercostal tube preparatory to a transdiaphragmatic attack on the primary focus. Great was the surprise to remark a complete disappearance of the diaphragmatic deformity on removal of the pleural accumulation, subsequent to which the patient continued to an uneventful recovery.

Naturally some doubt as to the infallibility of the cupped diaphragm as evidence of subphrenic abscess was aroused by this experience. That such a deformity might occur in the absence of both pleuritic adhesions and subphrenic abscess was established. To date 3 cases showing the cupped, or saucer, deformity of the diaphragmatic dome without concurrent subphrenic abscess have been added to the above.

Case II. M. G., an adult white male, was seen in consultation with Dr. H. M. Kay, Madison, Wisconsin, by whose courtesy the following history is furnished. Chills, fever and jaundice had been recurring at few days' intervals over a period of a month. A history of an earlier attack of gall-bladder trouble directed the attention to this organ, and marked right upper quadrant rigidity and tenderness were elicited. Chronic cholecystitis with possible empyema of the gall-bladder was diagnosed and cholecystectomy performed by Dr. T. W. Tormey, Madison.

The postoperative course was stormy, and bronchopneumonia with fibrinous pleurisy developed at the right base. The roentgenographic appearance of an extreme elevation and angulation of the right diaphragm led to the suspicion of a subphrenic abscess (Fig. 2), but the above cited experience lent caution, and several days later an abscess developed in the apex of the right lower lobe. The disappearance of the pleuritic friction rub was succeeded by a resumption of the normal diaphragmatic contour.

Case III. E. O. K., senile white male, aged seventy-two, was admitted to the Bradley Memorial Hospital complaining of chills, fever and vomiting. On physical examination questionable signs of fluid were determined at the left base. This conclusion was refuted by the roentgenogram which showed a high, deformed diaphragm (Fig. 3). Roentgenoscopy established fixation of the left diaphragm except in the extreme dome, where slight descent was observed on inspiration. The subsequent physical findings and clinical course established the diagnosis of bronchopneumonia at the left base. With resolution of the pneumonia the normal arc of the left diaphragm was restored.

Case IV. B. B., an adult white male, was admitted to the University Infirmary, complaining of pain in the right lower chest of a typical pleuritic nature. The presence of a patchy bronchopneumonia in the right lower lobe with attendant fibrinous pleurisy was established. The elevated, saucer-contoured diaphragm was observed to develop in a series of roentgenologic studies (Fig. 4), and the patient passed from observation before the deformity had disappeared.

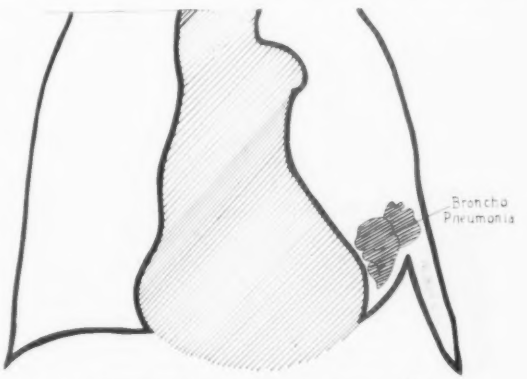

Fig. 3. Drawing from roentgenogram of Case III.

Altered motility and localized deformities, termed peaking or tenting of the diaphragm, have been described from the inception of roentgenologic study. Among the earlier workers, Williams[3] in particular emphasized the importance of routine systematic inspection of the diaphragm in pleuropulmonary affections. He recognized the relation of the diaphragmatic mirror to remote pulmonary infiltrations. Clinical studies of this condition have been both

common and noteworthy; but Matson[4] made the first critical analysis of the so-called tenting of the diaphragm. Clearly the mechanical influence of diaphragmatic synechiae is the simplest explanation for local irregularities of the dome; but roentgenographic progress studies have proved their disappearance in certain cases and others have failed of verification at necropsy. Matson by ingenious experiments proved that inelasticities of the lung, such as result from infiltrations above the

Fig. 4. Roentgenogram of Case IV.

dome of the diaphragm, might lead to deformity of this fibromuscular septum in its descent (Fig. 5).

In seeking an explanation for the deformity of the diaphragm herein described as occurring without subphrenic abscess or apparent diaphragmatic adhesions, obviously Cases II, III and IV might represent exaggerated tenting dependent on basal parenchymal inelasticity. Conceivably a relatively inelastic bronchopneumonic patch in the lower lobes might impose a local impediment to the descent of the diaphragm. Opposed to this plausible explanation as the sole factor in the production of the saucer deformity as observed in these 4 cases are several circumstances. In the first place, Case I showed an uncomplicated serofibrinous pleurisy. Furthermore, Case II displayed a return of the normal diaphragmatic dome with a maintained infiltration in the overlying lung. Lastly, Case IV showed a persistence of the deformity after resolution of the pneumonia.

Admitting a dual innervation for the

Fig. 5. Roentgenogram showing tenting of the diaphragm.

diaphragm, through the phrenic and the lower six intercostal nerves,[5] a theory has been formulated to explain this saucer phenomenon. Since in each instance where roentgenoscopy was available, motility was preserved, even though feebly, in the dome alone, it was felt that possibly inhibition of the intercostal innervation might account for this change—whether spastic or paralytic remained to be proved.

With the assistance of Prof. Walter J. Meek a series of dogs were studied with the above points in view. It was recognized that an independent intercostal motor supply to the diaphragm was not generally conceded. Schlaepfer,[6,7] after a critical review of the literature and histological and physiological studies of the diaphragm of phrenicotomized animals, concluded that the phrenic nerve constituted the sole motor nerve to this muscular sheet in

dogs. In the present relation his rather conclusive evidence was set aside in favor of the older morphologic studies, as those of Ellenberger and Baum,[7] and Cavalié,[9] who perceived the lower five or six intercostal nerves to send branches to the diaphragm. The outlined attack on this problem was pursued to determine whether by chance such intercostal innervation even though sensory[10] might not contribute reflexly to the control of the diaphragmatic movements.

Substantial support to Schlaepfer's position was obtained by the following experiments: First, section of the phrenic nerve well down in the neck led to complete cessation of movements of the diaphragm on the side affected. Slight transmitted movements through changes in intra-abdominal pressure were remarked, but such movements were paradoxical. The diaphragm, too, assumed a high position and the arc was increased (the larger arc of a smaller circle). Division of the several roots of the phrenic nerve seriatim in other dogs was not followed by segmental change in the diaphragmatic movements. Thereafter, the spinal cords of two dogs were exposed and divided in the upper thoracic region in order to block off the intercostal innervation to the diaphragm. No change was noted in the regularity, symmetry or extent of the phrenic excursion in either case; nor was there altered diaphragmatic movement on direct section of the lower six intercostal nerves in two dogs.

With the thought of calling into play some reflex mechanism such as would duplicate the circumstance of an acute fibrinous pleurisy, under which condition all four of the reported cases of phrenic deformity occurred, a series of dogs was exposed to varying forms of pleural irritation. Direct mechanical irritation at various points in the diaphragmatic and parietal pleurae resulted in inconclusive evidences of spasm in the case of the former. Chemical irritation by injections of croton oil or turpentine excited marked hyperpnea and bizarre changes in the diaphragmatic contour; but in no instance was there produced a saucer deformity nor was there evidence deduced for a separate intercostal motor innervation to the diaphragm. If sensory, no indication of a reflex inhibition of any segment of the diaphragm was gained through irritation of its fibers. From an experimental standpoint it was concluded that for the dog at least, the proposed theory of an inhibition of certain fibers or segments of the diaphragm supplied by the intercostal nerves in explanation of the saucer deformity is untenable.

CONCLUSIONS

An elevated, saucer-like deformity of the diaphragm has been found to occur independent of costophrenic synechiae in conditions other than subphrenic abscess. It is suggested that certain of these cases may represent an exaggerated tenting coupled with partial inhibition such as occurs in practically all pulmonary infiltrations. Another group would seem, by a preservation of movement in the mesial portion of the dome with fixation lateral to the angulation, to depend upon a segmentary inhibition. A ready explanation would seem to lie in the reputed dual motor innervation of the diaphragm. For the dog no such innervation could be established nor was there produced experimentally a saucer deformity.

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REPORT OF A CASE OF OSGOOD-SCHLATTER'S DISEASE

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EVANSVILLE, INDIANA

OSGOOD-Schlatter's disease is probably one of the most rare of the various types of epiphysitis. This condition was first described by Osgood in 1903 and by Schlatter in 1908.

The exact etiology is unknown. Various hypotheses have been offered as to the probable cause, some of these being: (1) a developmental error which manifests

FIG. 1.

itself at the stage of active bone growth; (2) a dyscrasia of the endrocrine glands; (3) an infective agent of attenuated virulence, and (4) an injury. Males, at about the age of puberty, are more susceptible to the condition than females.

The condition is so mild in its symptomatology that it is not until the patient has had an injury—probably a fall or a blow to the diseased part—that his attention is attracted to it. Physical examination may reveal one or all of the cardinal signs of inflammation (pain, heat, redness, and swelling). Pain may or may not be a prominent symptom. The diagnosis is definitely established from the roentgenogram. This usually reveals the bone nucleus in the epiphyseal lip of the tibial tubercle altered in texture, irregular in contour, or fragmented. Eventually, the bone fragments fuse and all traces of the lesion disappear.

CASE REPORT

Male, white, aged twenty, complained of pain in the right knee. This was intermittent in character—at times disappearing entirely, at other times, giving him considerable discomfort. Two months ago, he struck a hurdle while running, and for two weeks walked with some difficulty. At the present time, he can walk without any discomfort.

Past history revealed that six years ago he slipped on the ice and injured the same knee. The knee bothered him for only a short time and then gave him no further trouble until the injury two months ago.

Physical examination of knee shows some swelling of the soft tissue, with no redness, over the tibial tuberosity. There is some tenderness on pressure over the tibial tuberosity. The movements of the knee joint are not restricted. The patella is freely movable.

Roentgen Examination. Roentgenograms, anteroposterior and lateral, of the right knee show, at the site of the tibial tuberosity, a sharply defined, scooped-out area, the size of a navy bean. Lying just above this area, there has been some bone proliferation laid down parallel to the shaft, resulting in a small, tit-like, bony protuberance. This bony protuberance is of the same bone density as the cortex. Lying in the scooped-out area can be visualized a fragmented tibial tubercle, two pieces of which are of lesser bone density than the cortex, and one large piece—the size of a pea—which is of the same bone density as the cortex. The knee joint and patella are negative for definite bone pathology. There is some swelling of the soft tissue overlying the tibial tubercle.

Diagnosis. Osgood-Schlatter's disease.

Treatment. Because of the patient's age,

surgery was recommended. The patient refused operation. Rest and diathermic treatments to the diseased part were then recommended.

Prognosis. Ought to be excellent. The usual termination is for the tibial tuberosity to unite with the diaphysis. Further trauma, however, to the injured part may prevent this occurring, in which event, it might be necessary for the patient to submit to an open operation for removal of the fragmented tibial tubercle.

RADIUM CAPSULES IN STOMACH: GASTROSCOPIC REMOVAL*

BY LOUIS H. CLERF, M.D.

PHILADELPHIA, PENNSYLVANIA

FOREIGN bodies that have reached the stomach spontaneously without external assistance will usually pass unaided through the pylorus. This forms the basis of Chevalier Jackson's treatment of swallowed foreign bodies and has been borne out by the experience gained in many hundreds of cases observed at the Bronchoscopic Clinic. Exceptions are observed in cases of an abnormally small pylorus or of foreign bodies of unusual shape or size and are most commonly met with in very young children and in infants.

FIG. 1. Radium capsules and finger cot (actual size) removed from stomach by peroral gastroscopy.

The usual routine of the Bronchoscopic Clinic is not to interfere instrumentally with the foreign object until after a period of several weeks or even a month or more of observation by frequent roentgenoscopic and roentgenographic study. If then no

FIG. 2. Roentgenogram showing metallic radium capsules each containing 50 mg. of radium. They are contained in a rubber finger cot. Dr. J. T. Farrell reported that the foreign bodies were in the stomach.

* From the Chevalier Jackson Bronchoscopic Clinic, Jefferson Medical College Hospital.

progress is noted the question of removal can be considered.

In our experience gastroscopy affords the safest and best method of removal of foreign bodies from the stomach.

In the following case exception was made to the usual custom of observing the foreign body for a time before contemplating removal. Immediate action became imperative, not by reason of inability of the foreign body spontaneously to pass through the pylorus but because of the character of the object swallowed.

CASE REPORT

A boy, aged thirteen, was receiving radium treatments for sarcoma of the antrum of Highmore. Two capsules, each containing 50 mg. of radium element, and placed in a rubber finger cot (Fig. 1) were inserted into the posterior part of the nasal chamber and secured externally. At the termination of the period of treatment the radium was missing from the nasal cavity. On questioning the patient it was learned that about one hour before, he felt something in the throat which promptly disappeared on swallowing.

A roentgen-ray examination was immediately made by Dr. J. T. Farrell, Jr., who localized the foreign object in the stomach (Fig. 2).

In consultation with Dr. E. J. Klopp of the Surgical Staff, it was decided that gastroscopic removal should be resorted to. Without anesthesia, general or local, an 8 mm. gastroscope was passed into the stomach. With the aid of the double-planed roentgenoscope operated by Dr. J. T. Farrell, the foreign body was located and grasped with forward grasping forceps and removed without difficulty. The patient experienced no distress from the gastroscopy and sustained no apparent ill effects from the sojourn of the radium in the stomach.

The advantages of gastroscopic removal over surgical intervention were obvious. Without anesthesia, general or local, and without abdominal laparotomy certain definite risks were avoided. Convalescence was brief, the patient being able to leave the hospital the following day.

Peroral gastroscopy, in the hands of an experienced endoscopist, is the safest and best method of removal of foreign bodies from the stomach.

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FUNDAMENTAL PROBLEMS IN THE RADIATION TREATMENT OF CANCER OF THE ESOPHAGUS

REVIEW OF THE LITERATURE

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IN discussing the treatment of cancer of the esophagus, we are confronted with a problem which has resisted solution by any means at our command. In the treatment of neoplastic diseases, the management of these lesions has stood out as one of the most difficult and obstinate problems. It is the purpose of this paper to analyze some of the factors which render this disease so refractory to treatment, to review briefly some of the results of the treatment of these lesions by radiotherapy, and to discuss in what way some of the fundamental principles employed with success in the radiation treatment of cancer in other locations, may be utilized in dealing with this condition.

Usually, treatment of cancer of the esophagus can be only palliative; one is limited to fighting the cachexia of malnutrition, either by alimentary feeding or by means of a temporary or fixed catheter or by gastrostomy, the technique of which has been rendered relatively safe for old and very feeble patients, especially when the procedure is carried out under local anesthesia. Before proceeding with a discussion of the results of radiotherapy in treatment of cancer of the esophagus, the surgical treatment will be dismissed briefly, as it is not within the scope of this paper to enter into the details of this field. The invariably unfavorable results of surgery in dealing with these lesions are well known. Attempts to duplicate the one or two cases on record of apparent cures following extirpation of the tumor have met with failure. Recent efforts in this direction reported by Heuer and Reid proved unsuccessful, infection being the most frequent cause of failure. With the introduction and development of radiotherapy, those malignant conditions which were particularly unsuitable for surgery were given first trial with these new physical agents. Because of the marked variation in the quantity and quality of the radiation, as well as the methods of application, the comparative value of these methods cannot be adjudged. Furthermore, complete reports of the use of either roentgen rays or radium alone are not recorded in the literature. Reports of the combined treatment and some of the results obtained will be reviewed briefly.

Exner[1] of Vienna was apparently the first to treat cancer of the esophagus with radium (1904). He gave a dose of 60 milligrams of radium bromide in a platinum tube covered with rubber which he fixed in one end of an esophageal catheter. He used several short applications, for a total of twenty-four to thirty-six hours. By this treatment, in cases complicated by stenosis, the permeability of the esophagus was temporarily restored. The same year (1904) Einhorn[2] of New York used a similar technique.

In France, Guisez and Barcat[3] published their first results of radiotherapy in cancer of the esophagus in 1909. In 5 cases in which there was stenosis, tubes of radium bromide in increasing doses were used, at first 10 mg. in 0.5 mm. of silver and 1.0 mm. of rubber were left in place for two or three hours. After the opening had enlarged, a tube of 50 mg. was left in place for three to six hours. The treatment was continued at varying intervals. After the first few applications the dysphagia was greatly improved and the passage was rendered more permeable to bougies. Later statistics of 31 cases treated by Guisez[4,5,6] cited one case which had remained well for three years. In 1920 Guisez[7] followed his previous publications by a report in which he pointed out the dangers of radium applications in cancers situated high in the esophagus because of the difficulty in swallowing and violent paroxysms of coughing. He insisted on the necessity of proceeding at first with limited applications of short duration in order to test the sensitivity of the esophagus. He emphasized the dangers

of applying this method to patients who are already cachectic and dehydrated. His apparatus consisted of two tubes of radium bromide placed in tandem form with a filtration of 0.5 mm. of silver and 1.0 mm. of rubber. In 1922, the same author presented before the French Society of Laryngology[8] and Surgical Society of Paris[9], his remote results of treatment by radium of cancer of the esophagus. He pointed out that although in every case the problem should be approached with the idea of palliation which permits feeding for a longer or shorter time, certain patients have remained well, two, three and five years, and one case eleven years with a normal feeding and total disappearance of the tumor (revealed by esophagoscopy).

Moulonguet[10] advises treatment immediately, when the lesion is still in its early stages. The first step is an immediate gastrostomy in order to put the lesion at rest and disinfect it. Two weeks later, esophagoscopy is performed and a biopsy is made to confirm the diagnosis. A few days later, radium is placed in glass tubes surrounded by 0.5 mm. of platinum and 1 mm. of rubber. The tubes are placed in succession for 3 or 4 cm. in length, the sound is passed and held in place by a silk thread. The dose given is 25 to 30 mc. distributed over a period of six days. One month later careful dilatation of the stenosis is done to prevent cicatrization. At the same meeting Dufourmentel[11] reported 56 cases of carcinoma of the esophagus treated by radium. In spite of temporary improvement of from sixteen to eighteen months, all the patients ultimately died with early or late pulmonary accidents. Portmann's cases all died in from six to seventeen months. An international investigation including forty specialists on this subject concluded that neither radium nor roentgen rays have been able to produce a lasting cure of cancer of the esophagus. Before the Royal Society of London William Hill[12] presented a case much improved by radium applications. He utilized 50 mg. of radium in five applications at intervals of three weeks for a total of 100 hours. Following this presentation Hill[13] published 10 other cases which showed marked improvement. Finzi[14] advises especially the use of moderate doses with careful filtration as a palliative means of enlarging at least temporarily the caliber of the stenosis and to reduce or eliminate the principal discomfort of the patient. In 1921 Perthes[15] claimed improvement following combined roentgen and radium therapy and favored this method to surgery. In one case, esophagoscopy revealed that the tumor had completely disappeared. In 1915 Chevalier Jackson[16] made a special effort to improve the treatment of carcinoma of the esophagus by using heavily filtered radium in small doses. He used a filtration of 0.3 mm. to 0.5 mm. of platinum. Each session, lasting two to three hours was repeated every day up to a total of twenty-four to thirty-six hours.

Bérard and Sargnon[17] describe their technique which they have employed since 1914. The radium application is preceded by a gastrostomy under local anesthesia. The radium is placed in platinum tubes 0.5 mm. thick and fractioned in doses of 25 to 50 mg. These are placed in a rubber sound at varying heights along the estimated length of the tumor. The sound is introduced after esophagoscopy under control of the roentgenoscope. This is left *in situ* for twenty-four to ninety-six hours, depending upon the tolerance of the patient. The "sound method" is preferred. The essential precaution is to utilize a very soft sound so as not to injure the walls and to use extreme caution in order to avoid making a false passage. By using a weak solution of cocaine sprayed in the pharynx the procedure is simplified. By this method the sound has been kept in place twenty-four, thirty-six and even forty-eight hours without renewing it. With the "sound method" there is the advantage of being able to control the proper height of the radium tube by mere inspection. The total duration of the application varied from two to six days depending upon the desired effect.

ACCIDENTS AND COMPLICATIONS

Accidents in the treatment of cancer of the esophagus by radium are so common and occur with such regularity as to merit special consideration. A large percentage of the 56 patients reported by Dufourmen-

tel died with pulmonary accidents. Samaja reported a case in which vomiting of blood and violent spasms of coughing occurred a few days after treatment and in which autopsy revealed gangrene and perforation. Moulonguet in 1921 reported that one of his patients treated in 1920 by an intra-esophageal application of radium, expectorated a fragment of the tumor, and esophagoscopy revealed a communication between the esophagus and trachea. He concluded that in spite of all care and precaution, it is impossible to avoid accidents as one cannot tell by direct examination how deep the tumor extends or how far the destructive effect will reach. In most of the cases treated, esophageo-tracheal, pulmonary or pericardial fistulae have occurred. Le Mée[15] reported a case of fatal hemorrhage after removal of the radium tube. In 1922 Schambacher and Desdous published a case in which death occurred from bronchopneumonia and autopsy revealed a fistula between the esophagus and left bronchus. Patterson and Howarth give extremely variable results in subjects with identically the same maneuvers and technique. The reactions are always marked, resulting occasionally in a simple disappearance of the lesion, more often, however, in hemorrhage, sometimes in diffuse gangrene, bloody vomiting and rapid death. Speaking before the International Congress of Surgeons, Regaud[19] warned against the danger of applying radium to hollow organs susceptible to perforation.

Perforation is a very common complication occurring in the natural progress of the disease. It occurred in 26 out of 46 cases of cancer of the esophagus reported by Piperkof (56 per cent). In Petri's series it occurred 27 times in 44 cases, or 61 per cent. In Samaja's groups of combined cases collected from the literature in which perforation occurred, 8–.5 per cent were into the respiratory tract and 9 per cent into the vessels and pericardium. Ulceration is nearly always present. Only one of Piperkof's 47 cases was non-ulcerated and only 4 of Bietlin's 53 cases showed no ulceration. This is due to a number of factors: traumatism to the mucosa by large and poorly masticated fragments of food, simple necrosis or infection and retention and stagnation of food in pockets. Most important, however, are the ulcerations and perforations caused by too vigorous exploration with the esophagoscope.

The following is a report of a case in which perforation occurred into the aorta with sudden death from hemorrhage:

J. R., aged fifty-nine, first noticed a discomfort in the chest about six months ago. Two months later he began to have difficulty in swallowing. For the past four weeks he has been able to swallow only liquids. There has been a loss of weight of about 12 pounds during the last six months.

Physical examination revealed an elderly man in fair general condition, there was some evidence of recent loss of weight. The heart, lungs, abdomen and extremities were negative. Roentgenographic examination revealed a constriction at the junction of the middle and lower thirds of the esophagus with some dilatation above this point. Esophagoscopy revealed a constriction at the point indicated in the roentgenogram, with an ulcerated bleeding lesion at this point. The pathological report of a biopsy specimen was "squamous cell carcinoma." Treatment consisted of gastrostomy followed by intra-esophageal application of radium in a rubber sound. Two tubes of radium bromide each containing 25 mg. covered with 0.5 mm. of silver and 1 mm. of rubber were left *in situ* for forty-eight hours totalling 2400 mg-hr. There was very little reaction during and following treatment, except for a marked salivation which lasted for two weeks. Four weeks after treatment the patient died suddenly at night with a profuse hemorrhage from the mouth. Autopsy revealed at the junction of the middle and lower thirds of the esophagus a sloughing, ulcerated and infected carcinoma. At no point could solid tumor tissue be found. At one point, the mass was adherent to the aorta and had perforated into the lumen causing death from hemorrhage (Fig. 1).

The extreme difficulty to cope successfully with this condition by radiotherapy is best explained by a consideration of certain fundamental factors. Because of its situation, being in immediate contact with important organs, because of its depth, especially the abdominal and thoracic portions, the esophagus is an organ accessible only with difficulty. A determination of the extent of the disease is also extremely difficult. A most important anatomical consideration which seems to have escaped

general notice and which has a most important bearing upon the problem is the extreme thinness of the esophagus. Careful observation of this organ at autopsy will reveal a surprising delicacy and thinness which to a great extent accounts for the frequent perforations (Fig. 2).

Observation of anatomical changes in the natural course of the disease readily demonstrates that the accidents of perforation, necrosis and hemorrhage take place

FIG. 1. Perforation of a carcinoma of the esophagus into the aorta causing sudden death from hemorrhage. Note thrombus on lumen of aorta.

in moderately advanced cases without radiation. It is important to appreciate that at the time radiation treatment is instituted, extension of the disease may have already occurred into the surrounding structures and that the accidents which follow are more frequently hastened than caused by the treatment. Perhaps the one most important factor which renders the accurate treatment of this disease so difficult is the inability to determine by any method of examination the extent to which the disease has already involved the closely neighboring vital structures. Although some of the accidents may be due to faulty technique, many are caused by the destruction of the few neoplastic cells which form the only communication between the esophagus and neighboring organs. Sincert states, after investigations made in a number of countries, particularly in Germany, that the application of radium to the interior of cancer of the esophagus is always dangerous because of the impossibility of knowing the thickness of the wall remaining and the impossibility of reducing at will the destructive action of the radium. Because of the absence of precise knowledge of reactions of normal tissues to radiation, it is difficult to use a precise radiation technique. The

FIG. 2. Diagram showing relation of esophagus and aorta. This anatomical feature accounts for the frequency with which esophageal cancer perforates into the aorta.

Germans prefer a single massive dose, whereas the French employ smaller doses over an interval of six to eight days.

SUMMARY AND CONCLUSIONS

A review of the literature shows that the results of treatment of cancer of the esophagus are most unsatisfactory as to cure. By combined roentgen and radium therapy palliation for as long as two, three and even five years may be obtained, with

a relief of symptoms, an improvement in the stenosis and in some cases a disappearance of the lesion as revealed by the esophagoscope. The principal difficulties consist of the inability to determine by examination the extent of the disease, the difficulty of early diagnosis and the peculiar anatomical conditions. The thinness of the esophagus, its deep situation, and its relation to the aorta and bronchi are the special anatomical peculiarities which render lesions of this organ difficult to treat.

Accidents in the treatment of this condition occur with great regularity and frequency. Necrosis, hemorrhage and perforation with pulmonary involvement are the usual complications.

It is important to realize the futility of attempting to cure lesions which are advanced. Autopsy evidence shows that in the natural course of the disease, important neighboring organs are involved early and only palliation should be attempted. An attempt to treat such cases by intra-esophageal applications of radium will meet with inevitable failure and result in death from hemorrhage or perforation.

Clinical experience has shown that external irradiation may at times result in a marked improvement in swallowing and relief of pain and may retard the progress of the disease for some time. Gastrostomy is universally recognized as an essential part of the treatment of this condition and to be of use should be done early.

The future hope in the treatment of cancer of the esophagus lies in early diagnosis and application in the esophagus of moderately large doses of heavily filtered radium extending over a long period of time, limiting the treatment to early cases and employing external irradiation as a palliative measure in the more advanced cases.

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LYMPHOBLASTOMA (HODGKIN'S DISEASE) OF THE ORBIT*

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MUCH has been written on the various manifestations of Hodgkin's disease,[1] but in the review of the literature I find very few cases in which the first symptoms are referable to the orbit and which show no other clinical findings. Mikulicz was perhaps the first to recognize the lymphatic involvements about the face. He considered these lymphatic growths as representing a morbid entity, allied to but not identical with pseudoleucemia, and often called lymphosarcoma.

Goldzieher[2] reported a case in 1907 which he diagnosed as lymphoma of the conjunctiva. The same year Meller[3] discovered a similar case. A few cases have been reported in recent years.[4] Bedell[5] in 1921, reported a case which he diagnosed as "solid edema lymphoma of the eye." Pfahler[6] reports a series of cases of sarcoma of the orbit, most of whom he has treated primarily with roentgenotherapy, and with very satisfactory results.

In reviewing the lymphatic structures of the eye, we find very little lymphoid tissue in the orbit. The conjunctiva and lacrymal gland are the chief extrabulbar structures that contain any amount of lymphoid tissue. Lymphomatous masses may appear in any portion of the conjunctiva. Some contend that the growth begins in the retroconjunctival region and secondarily involves the conjunctiva. Diffuse lymphoid tissue is found in the stroma of the conjunctiva but lymph nodes are of rare occurrence.

The conjunctiva possesses the lymphatics which go to make a superficial and a deep plexus. These form a minute plexus at the margin of the cornea and probably communicate with those of the cornea.

Lymph nodes are also rare in the eyelid. The lymphatics of the eyelid form two groups; a superficial and a deep group. The former drain the skin and orbicular muscle. The latter drain the tarsal plates and conjunctiva. Those of the upper lid drain into the preauricular nodes while those of the lower lid and lacrymal gland drain into the submaxillary region.

DIFFERENTIAL DIAGNOSIS

In the differential diagnosis, it is not always an easy matter to rule out malignant tumors of the orbit, namely carcinoma and sarcoma. For this reason patients who present themselves to a physician for treatment are usually advised to have the eye removed.

All of these tumors, if intrabulbar, produce a certain amount of unilateral exophthalmos. The small cell sarcomata occurring in the lymphoid tissues of the orbit spread into the stroma, separating its alveoli and causing extensive degeneration of the lining epithelium. They may be a little slow in growth but ultimately break through the capsule of the gland or node and invade the orbit.

Another condition to be differentiated is one termed by Verhoeff "retinal blastoma." This condition is often termed glioma and starts in the pars optica, pars ciliaris retinae or in the supporting tissues of the optic nerve.

In cases of exophthalmos and apparent tumor, especially in young children, chloroma must be ruled out, as it does not respond to irradiation. This condition can usually be diagnosed relatively early, however, by the blood examination.

Still another form of growth in the parenchymal tissues of the lacrymal gland is a mixed cell tumor of mesoblastic origin. These occur only in adult life, are never multiple and do not recur if removed. They are composed of columns of endothelial cells, fibrous and myxomatous tissue and hyalin cartilage.

TECHNIQUE

Where roentgen therapy was employed we made use of high voltage rays, that is 200 kv., 4 ma., filtered through 4 mm. of

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aluminum plus 0.5 mm. copper, at a distance of 50 cm.

Where radium therapy was employed we made use of highly filtered gamma rays. A filter of either 0.5 mm. silver or 1.0 mm. brass was found to be most satisfactory. A distance of from 1 to 3 cm. from the skin surface was usually selected.

Several different portals of entry were used, directing the rays posterior to the lens when possible. Pfahler uses six small portals of entry, care being taken to give the lens less than 100 per cent of a skin unit.

Cases have been reported, developing cataract, following irradiation of the orbit. Mueller[7] records the sensitivity of the tissues of the eye on the same percentage basis as the skin unit dose; the conjunctiva and sclera 100 per cent; cornea from 120 to 130 per cent; lens from 90 to 100 per cent.

None of our cases have as yet developed lens changes. A probable explanation of this is that a full erythema dose is not necessary to destroy the lymphoid tumor. Never more than two-thirds of an erythema dose was given to any one patient.

In reviewing the cases of lymphoblastoma (Hodgkin's disease) at the Massachusetts General and Huntington Memorial Hospitals, a total of approximately 500 cases were studied. Only — of these were found where the condition as far as could be determined had its primary focus, or beginning, in the tissues of the orbit. Only those cases were chosen which presented their first symptoms without evidence of disease elsewhere. All of these patients with the exception of one, were under forty years of age. The first symptoms noted were either a firm freely movable mass in the orbital tissues or exophthalmos of the involved orbit. The patients had no pain and came for examination only after the growth had begun to give pressure symptoms. Four of them presented intrabulbar tumors and these had enucleation of the involved eye.

Not all of our cases will be reported in detail and only the most interesting are herein described.

CASE REPORTS

Case I. C. V., an Italian laborer, aged twenty-eight, entered the Massachusetts General Hospital in August, 1925, complaining of a growth in the inner canthus of the right eye, of two months' duration. The patient had had no pain and only noticed the growth when told about it. Physical examination showed a fairly well-nourished man without palpable glands and a spleen slightly larger than normal. The liver was felt two finger breadths below the last rib. The blood and urine examinations were negative. Examination of the eye revealed a granular tumor mass 2×6 cm. in diameter, extending into the conjunctiva from the inner caruncle toward the cornea. It also involved both fornices and the conjunctiva of the lids above and below. A specimen was removed for diagnosis and a report of lymphoma was returned.

It was decided to treat the eye locally and two applications of radium were given. A filter of 0.5 mm. silver was used at a distance of 1 cm. from the skin surface. The eyelashes and eyebrows were protected and the rays directed toward the inner canthus, thus protecting the lens from the direct rays.

In four weeks the eye was apparently normal and the patient felt well except for a hacking cough. Two months later he returned with the picture of generalized Hodgkin's disease. There was no recurrence in the orbit.

Case II. An Italian laborer, aged twenty-eight, first entered the Massachusetts Eye and Ear Infirmary in 1920, complaining of a gradually increasing swelling of the right eye for the preceding few months. For three years he had noticed a slight swelling of the eye at times, more evident in the morning. He had no other discomfort and paid little attention to it.

A physical examination showed about 8 mm. exophthalmos of the right eye. No note of the eye grounds was made at this time. The blood and other physical examinations were negative. The eye was removed in February, 1920. The lacrymal gland was found to be hard and a dense mass was discovered at the outer angle of the orbit, extending back into the orbital cavity. The pathological report was "scirrhous lymphoma." The patient made an uneventful recovery and failed to report for subsequent examinations.

Case III. A white woman, aged twenty-nine, came to the Huntington Memorial Hospital in November, 1920, complaining of a mass and pain in the left orbital cavity. The eye had been removed at the British Hospital in Constantinople eight months previously. Her symptoms previous to the enucleation had been unilateral exophthalmos, failing vision and pain. A pathological report was obtained from the British Hospital and a diagnosis of syphilis with periosteal thickening of the external wall

of the orbit had been made. They also reported a negative clinical history of syphilis.

On physical examination at this time, small glands were present in the neck and left axilla. The spleen was somewhat enlarged. A blood examination showed the hemoglobin 75 per cent; red cells 4,000,000; platelets 160,000 (Buckman); white cells 7,000. A differential count showed a moderate eosinophilia; polymorphonuclears 60 per cent; lymphocytes 15 per cent; mononuclears 3 per cent; eosinophils 15 per cent, and atypical lymphocytes 7 per cent.

Radium was applied in the form of filtered plaques to the orbit and to the glands over the neck and axilla. A month later the glands had changed very little. A Wassermann at this time was negative, but on the basis of the previous report, she was given a series of injections of neosalvarsan.

In May, 1921, she returned to the outpatient department with evidence of new growth in the walls of the orbit. A biopsy was done and a diagnosis of scirrhous lymphoma was made by two pathologists.

Filtered radium was applied to the orbit in one-half erythema doses. The treatments were given monthly and all symptoms subsided, except for occasional headaches.

In August, 1925, she was still free from symptoms. The physical and blood examinations were negative. The orbital cavity was clean and there was no evidence of recurrence.

CASE IV. A white woman, aged seventy-four, first came to the Massachusetts Eye and Ear Infirmary in July, 1916, complaining of swelling and protrusion of the right eye. For the preceding year the eye had been slowly becoming more prominent and vision was failing. Roentgen examination at that time showed the right orbit to be diffusely obscured, and a question of periostitis of the orbital wall was raised.

Physical examination showed the eye to be pushed outward and downward. The conjunctiva of the outer lid was everted and the tarsal fold was shallow. The ocular conjunctiva was moderately injected.

Ophthalmoscopic examination showed a shallow anterior chamber. The pupil was dilated and did not react to light. The fundus was pale and the disc was faintly seen. There were no marked retinal changes. The left eye was normal.

In December, 1917, the eye was removed and a growth was found extending upward and backward around the optic nerve, pushing the eyeball forward. The pathological report was lymphosarcoma, this being the term which was in use at that time to cover practically all the lymphoid tumors. One month later new granulation tissue appeared but promptly disappeared under roentgen therapy. The physical and blood examinations were negative.

The patient returned again in November, 1920, complaining of pain in, and exophthalmos of the left eye. The eyelids could be only partially closed. There was marked cloudiness of the lens so that the eye grounds could not be clearly seen. Radium plaques were applied and 700 mg-hr. were given. A filter of 0.5 mm. brass was used at a distance of 2.5 cm. from the skin surface. A month later the symptoms were much less pronounced. A series of several monthly treatments of filtered radium were applied, averaging about one-half of a erythema dose each time.

In March, 1921, there was no exophthalmos. Physical examination was entirely negative except for a few small glands in the left side of the neck.

In June, 1923, she returned to the hospital complaining of a slight swelling and some pain in the region of the left parotid. An application of 2,300 mg-hr. of radium was given. Symptoms readily subsided and in 1925 she was in good physical condition, with no evidence of recurrence.

CASE V. C. W. A Chinese, male, aged thirty-six, entered the dispensary of the Massachusetts General Hospital on January 2, 1926. Two months previously he began to have pain in the left eye which gradually grew worse. He was referred to the Massachusetts Eye and Ear Infirmary for diagnosis.

Examination showed a soft granular tumor of the upper part of the left conjunctiva extending from the limbus backward about 2.5 cm. A section of this tumor was removed for examination. The pathological diagnosis made by Dr. Verhoeff was malignant lymphoma, and the patient was referred back to us for treatment.

A physical examination failed to show involvement other than of the eye. Roentgenograms of the chest were negative. Filtered radium was applied to the left upper lid. Two weeks later he returned for observation and was free from pain. Two weeks later the tumor mass had almost completely disappeared. There was no evidence of other glandular enlargement and the patient has not had a recurrence.

SUMMARY

1. Lymphoblastoma (Hodgkin's disease) may occur locally about the orbit with no other clinical findings.

2. This condition should always be ruled out in all extra- or intra-bulbar

tumors, either by biopsy or therapeutic irradiation.

3. The dosage necessary to affect the tumor will not produce lens changes.

4. There is no pain from this form of treatment, and the chances of recurrence are much less than where surgery is employed.

5. Our follow-up on some of these cases shows them to be practically well. The prognosis of these cases therefore is much more favorable than those showing generalized lymphadenopathy.

6. The extra-bulbar tumors have a tendency to remain localized and only one of our cases has developed generalized lymphadenopathy after the initial findings in the orbit.

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"GRENZ" (INFRA-ROENTGEN) RAY THERAPY

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NEW YORK CITY

I

WHEREAS in the Nineteenth Century chemical therapy played the greatest part in medical treatment, we now observe how physical therapy is gaining ground; the latter is still underestimated. On the other hand, the multitude of chemical preparations indicates that there is still too much expected from drugs which so far have not fulfilled expectations. This is proven by the fact that so many of the advertised remedies disappear quickly in order to give room to others.

The greatest results in physical therapy, no doubt, were obtained by applying rays, i.e., electromagnetic oscillations. Some of these electric waves are made use of in diathermy, light, ultraviolet, roentgen and radium therapy; but there are still large areas in the ray spectrum which so far have not been utilized in medicine. Speaking of a spectrum, we understand an order of different rays, according to their wave lengths, so that on the one end of the spectrum we find the longest and on the other end the shortest waves. It is quite interesting that biologic effects are not proportional to the wave lengths, but are characteristic of certain regions of the spectrum.

One of these regions in the spectrum which up to date has not been employed in medicine, exists between the ultraviolet and the roentgen rays. When I compared the biologic effects of the ultraviolet and roentgen rays, I found that there are not many symptoms which resemble each other, and that there are quite fundamental differences in the action of these two kinds of rays. Some authors have made the assumption that the differences are due to the difference in penetration, but, on the other hand, we have to keep in mind that the biologic effects are not proportional to the wave length, as was mentioned above. So I concluded that the penetration power is only one factor in the biologic action; besides others which are still to be studied. These conceptions are the foundation of my studies of the region of the spectrum between the ultraviolet and roentgen rays, and I was fortunate enough to be able to confirm the correctness of my assumptions. These facts have led

me to an entirely new therapeutic method, the value of which cannot as yet be properly estimated. It is so promising that I consider it my duty to make it known to physicians, being well aware that many studies have still to be made in the future.

Such rays are produced in tubes quite similar to roentgen tubes, but they show *characteristic biologic effects*, which are observed partly with ultraviolet and partly with roentgen rays. In addition to these, *new biologic effects* were found, not obtainable with any of the other rays. Despite the fact that we are dealing with physically related energies, we have to differentiate them carefully as far as therapeutic effects are concerned. Physically, these rays are electromagnetic oscillations (infra-roentgen rays) of a wave length of about 1.5 to 2.0 Angström units (i.e. 1.5 to 2 ten-millionths of a centimeter).* They are characterized by their small penetration power, so that almost all their energy is absorbed by tissues, e.g., skin of about 2 mm. thickness.

II

This intensive absorption is one of the causes of their powerful biologic action, as only the absorbed rays are able to create reaction.

From Table I it can be seen that the sum of the biologic actions of the "Grenz" rays is so different from those observed with ultraviolet and roentgen rays, as not to be identified with either of them. Nevertheless, a certain continuity can be noticed, as the identical symptoms are found with the "Grenz" rays and one of the other radiations. In addition, there are effects obtainable with the "Grenz" rays only. These are shown in Table II.

As far as I know, no erythema has been described without a marked local rise of temperature. This rise was always considered to be one of the fundamental symptoms of inflammation, so that we can hardly speak of inflammation with the "Grenz" rays. Only one of Galen's cardinal symptoms of inflammation is really present and that is "rubor," whereas "tumor," "calor" and "dolor" are either entirely absent or unusually slight for a genuine inflammation. We may, therefore, have to deal here with a new intensive action of the skin. As shown in Table II, no real irritation of the sensitive nerves is seen with the "Grenz" rays, neither during the application, nor later, when reactions are developing.

The most interesting effect is the drop of the leucocytes in the blood. The leucocytic drop is not identical with the leucopenia.

TABLE I

Symptoms		Ultraviolet	"Grenz" Rays (Infra-roentgen)	Usual Roentgen Rays
Epilation		—	—	+
Erythema	Latent period	Some minutes or hours	Some minutes to 5 weeks	Some days to 3 weeks
	Duration	About 1 week	Many weeks	Some weeks
Bullae		+	+	+
Ulceration		—	+	+
Sequelae	Pigmentation	+	+	+
	Telangiectases	—	—	+
	Atrophy	—	—	+
	Scaling	+	+	—
	Restitution	+	+	—

In Table I the action of ultraviolet and roentgen rays can be compared with the infra-roentgen rays here in question, which I call "Grenz" rays ("Grenz" meaning "borderline").†

TABLE II

Symptoms		Ultra-violet	"Grenz" Rays (Infra-roentgen)	Usual Roentgen Rays
Erythema	Local temperature rise	Marked	Practically none	Marked
	Sensation	Marked	Practically none	Very marked
Drop of leucocytes		—	+	—

*Schultz and Zehden, in Germany and Stern of New York have experimented in the past with so-called oversoft roentgen rays near the above-mentioned region. To ascertain the proper and new results it is essential to use no shorter wave lengths than 1.5 A., which obviously was not done by them. Their work was done for very different reasons, so that they were not aware of the new biologic actions which will be described later on.

†The name was chosen, because the region of the spectrum in question is really the borderline between the biologic effects of the ultraviolet and roentgen rays.

The drop is characterized by the temporal course, the percentage and the restitution to normal; it is shown schematically in Table III.

TABLE III

About five to ten minutes after irradiation the number of leucocytes is suddenly diminished to 20 to 30 per cent of the normal number. In the course of about twenty-five to thirty minutes the number of leucocytes is again what it had been before the irradiation. A real leucopenia requires days or weeks for the regeneration of the leucocytes. The leucocytic drop, on the contrary, cannot be caused by a destruction of the cells, because it is quite obvious that a regeneration requires more time than a few minutes. Furthermore, the amount of the drop is practically always the same; it does not depend upon the energy applied, but it is a well-established fact that a genuine leucopenia depends upon the intensity of the damaging factor.

Müller and Peterson in Chicago* have proven that in animals the missing leucocytes can be found in the splanchic region during the drop, especially in the liver. With the drop, the leucocytes are, therefore, removed from the skin or the surface of the body to the inner organs. This interesting phenomenon can be explained by nerve action only and, as it can be produced by will-power, we must assume that the "Grenz" rays have a distinct effect on the autonomic nervous system. This assumption is supported by the fact that the entire skin reacts as a whole, no matter where the skin is irradiated and from what part of the skin the blood is taken. That means that every part of the skin shows the drop of the leucocytes, even if the blood is taken from a part of the skin distant from the irradiated area. It is surprising by how small an amount of ray energy this phenomenon is produced. One-sixteenth of the energy necessary to produce a very slight erythema is sufficient to cause the drop.

*The authors produced the leucocytic drop by intravenous injections. Subcutaneous injections do not cause the drop. It is negligible whether air, water, saline solutions or other matters are used, only specific drugs are to be avoided.

III

So much for the theoretical consideration. What is the practical advantage? Primarily it may be assumed that rays absorbed to such an extent by the skin must have a tremendous curative value in skin diseases. This fact was easily proven and will be described later on—but there are other advantages.

If we analyze the usual roentgen-ray method in skin diseases, we realize the fact that the larger percentage of applied ray energy, which penetrates the skin, is more or less unused. Only the smaller percentage is absorbed and, therefore, has an effect. To illustrate: with the roentgen rays of shorter wave length used up to now, no more than about 10 per cent of the energy is absorbed when working without filters, and only about 5 per cent when operating with filters (after Rost). This means that deeper layers are stricken unnecessarily. There is another consideration: the ideal ray therapy always aims to make *restitutio ad integrum* possible; in other words, to save cells which are necessary for regeneration. We should, therefore, consider the skin not as a whole, but keep in mind its individual layers, especially the germinative layers. This does not mean that no ray should be allowed to reach these layers, but that the amount of ray energy absorbed should not be such as to cause damage.

Figure 1 shows the conditions schematically. "s" represents a cross section of the skin and the cones I, II, III and IV the absorption of incident radiation. The height of the cones depends on the penetrative power, i.e., the wave length of the rays, which means that the penetration is greater in cone IV than in cone I. The bases of the cones represent the applied dosages (erythema dose in cones I, II, III, and less than an erythema dose in cone IV). It is obvious that by increasing the dosage, the depth dosage increases, as shown by the dotted line at cone I. When using a penetration such as in cones II, III and IV, the hair papillae, P, underneath the skin can be reached and

epilation can be produced. This, however, does not happen if proper wave lengths are used as in cone I, where also the basal cells are saved. It is obvious for the expert that with such means an erythema can be produced without epilation, whereas, according to our former knowledge, the epilation took place with dosages not large enough to produce an erythema (cone IV).

The four fundamental conceptions for skin treatment may be summarized as follows:

(1) The germinative layer of the skin should not be damaged (cone I).
(2) Rays penetrating the skin are more or less useless (cones II, III and IV).

The clinical advantages of my new method are as follows:

(1) Practically absolute safety.
(2) Markedly shortened healing period.
(3) Possibility of replacing changed skin with normal skin.
(4) Remarkable cosmetic results.
(5) Lack of danger of repeated irradiations.
(6) New indications.

Many skin diseases react wonderfully to this treatment, such as eczema of all kinds, acne rosacea, lichen planus, pruritus ani; psoriasis came back after a short time.

Of the infectious diseases the following reacted very well: Lupus, trichophytosis,

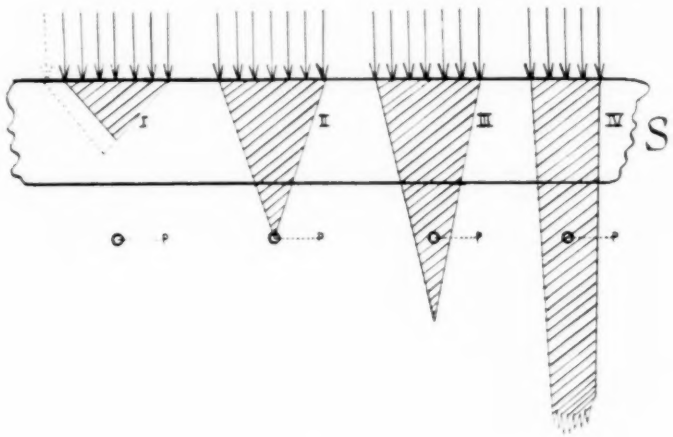

FIG. 1.

(3) Ray absorption in tissues underneath the skin is not desirable.
(4) When increasing the ray absorption in the skin, the incident energy necessary for a biological effect decreases (cone I).

With such a procedure all the dangers of the ordinary roentgen treatments are avoided. What makes the roentgen-ray burns so terrible is the damage done to the germinative layers preventing restitution. As these layers are practically not reached by the rays in question, the burns produced by them turn out to be entirely harmless. Of course, blisters and also slight defects of the uppermost layers can be obtained, but they always heal with normal skin within a few weeks. No pain is connected with them which, with ordinary roentgen burns, is almost unbearable. Thus astonishing curative effects are obtained.

sycosis vulgaris, herpes tonsurans, kerion celsi, paronychia, angulus infectiosus and carbuncle; of the tumors: warts, mycosis fungoides, Kaposi's disease and epitheliomata. The malignant tumors heal without leaving scars or other consequences. That has to be emphasized, because it shows its superiority over other methods, like carbon dioxide snow, etc. Generally one or two treatments are sufficient to destroy the lesion.

IV

We had a good reason for explaining the leucocytic drop in detail. There is not only a theoretical interest, but also a very important practical one concerning the influence on the autonomic nervous system. Such experiments are apt to change our conceptions of a number of diseases, the

origin of which has not been known, or has been misinterpreted.

For instance, it seems to be the disturbed autonomic innervation which causes intestinal bleedings if a certain area of the skin is burned by fire. There are connections between the skin and the bone marrow by means of the autonomic nervous system. Many of the spastic conditions may be due to similar disturbances. The correctness of such assumptions was proven by the following facts. Cases of ulcerations of the stomach or duodenum react very favorably to the "Grenz"-ray treatment. There is also a marked improvement, if a mixed diet is given and all drugs are avoided. In a number of cases all the subjective symptoms disappeared within a short time. However, it is hard to judge such cases properly, as we are depending mostly upon subjective descriptions. Therefore, a much better and extremely interesting proof was found in cases of polycythemia rubra vera (polyglobulia). We treated 2 cases, avoiding any other treatment, with the result that both came back to normal. The number of the red blood cells was about 8 million in the one, and 10 million in the other case. The hemoglobin came down from 150 per cent to 105 per cent and from 140 per cent to 105 per cent respectively, after some weeks. The second case went up to about 7 million again, but after a second treatment came down to 5.3 million. It is remarkable how the subjective symptoms vanish in such cases. It was a feature of special interest that one of these patients was suffering from an ulceration of the duodenum at the same time. The symptoms of the ulcer disappeared entirely during the treatment, though no special medication or diet was used. That gives the idea of different appearances, though the origin of the diseases probably reverts to the same root. However, the "Grenz" rays cured both diseases simultaneously. I consider this fact to be of importance for further investigations and observations.

V

Another very interesting and promising field is that of certain spastic conditions. We have to differentiate between conditions where the effect of "Grenz" rays can be only a symptomatic one, and those in which the rays are able to strike the source of the disease.

To the first group belongs whooping cough. I was able to observe that the attacks stopped in the course of about two days and no relapse was noticed afterwards. We cannot assume that the disease is cured by the rays, as we know that *we are dealing with an infectious disease*. On the other hand, we require about sixty times more ray energy to kill a colony of bacteria, than is applied with our treatment. However, one conception may lead to an explanation. We know that "Grenz" rays and nonspecific injections (protein) lead to the very same leucocytic drop. No doubt, there are similar effects with both. Furthermore, we know that nonspecific injections stimulate and activate the body against infectious processes. In this we may find the explanation for the stimulating action of the rays in infectious diseases, enabling the body to produce antibodies. From this viewpoint I began to treat cases of acne vulgaris of the face with general irradiation of the body, not touching the local affection. The results are promising. The idea is not too far fetched, as we know that ultraviolet and roentgen rays show analogous effects, only that the irritation of the skin by means of the "Grenz" rays is an incomparably stronger and more specific one.

The second group of cases comprises: Asthma bronchiale, spastic constipation, status thymolymphaticus, irritation cough in children lacking a provable cause.

Children of the status thymolymphaticus type, especially in the first year of age, show characteristic attacks of convulsions, Sometimes we find an enlarged thymus which may also show symptoms of compression. Dr. Reuben of Beth Israel Hospital sent such cases for deep roentgen therapy, and we observed good results. No doubt, the autonomic nervous system plays an important part in different spastic conditions. Assuming that that may be true also with the cases in question, he agreed to try my method. The results were very satisfactory. Almost all the cases reacted very well, i.e., the convulsions ceased mostly

after the first treatment. One case with enlarged thymus showed a definite decrease of the thymus, despite the fact that no such ray could reach the gland, as explained before. We consider these diseases to be an endocrine disturbance. Many authors are of the opinion that the autonomic nervous system, as a regulation factor for endocrine secretion, may be the cause of such disturbances. If that be true, a vast and new field may be opened in therapy. The future will reveal their relationship and possibilities. The matter is too complicated to permit a definite statement at this early stage.

However, our assumptions are supported by cases of spastic constipation in nervous persons, in which good results were obtained. Asthma bronchiale seems also to react favorably. No more should be said at the present. Hundreds of cases must be treated before we can see our way clearly.

In a previous publication we referred to roentgen therapy in children suffering from irritation cough, lacking a provable cause. The children were examined thoroughly, but no affection was found. These children reacted promptly to "Grenz"-ray therapy. The cough stopped entirely. The sleep was no longer disturbed. They gained in weight and their appearance was entirely different.

So much for the diseases treated up to now. We are next going to treat larynx and eye diseases which appear likewise promising. Experimental studies were begun to make certain that no untoward consequences would occur. Diseases of the larynx require new technical means which are being perfected.

Admitting that much has still to be done, we can already state that the "Grenz" rays represent a new therapeutic means of their own, which may enrich our therapeutic possibilities.

SUMMARY

(1) Electromagnetic oscillations of a wave length of about 2 Angström units produce new biological effects.

(2) These "Grenz" rays are entirely harmless, because with the proper technique, they are absorbed by the uppermost layers of the skin, saving the germinative layer.

(3) These "Grenz" rays may perhaps replace, to a great extent, the usual roentgen rays in dermatology.

(4) The results of this therapy in disturbances of the autonomic nervous system and endocrine secretions are very promising.

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Vol. XVII, No. 6

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Publishers: PAUL B. HOEBER, INC., NEW YORK

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application. Editorial office, 1909 Massachusetts Ave., N.W., Washington, D.C. Office of publication, 76 Fifth Avenue, New York.

Information of interest to all readers will be found on page ii.

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Publishers: PAUL B. HOEBER, Inc., 76 Fifth Avenue, New York City.

Twenty-eighth Annual Meeting: Montreal, Can., Sept. 20–23, 1927.

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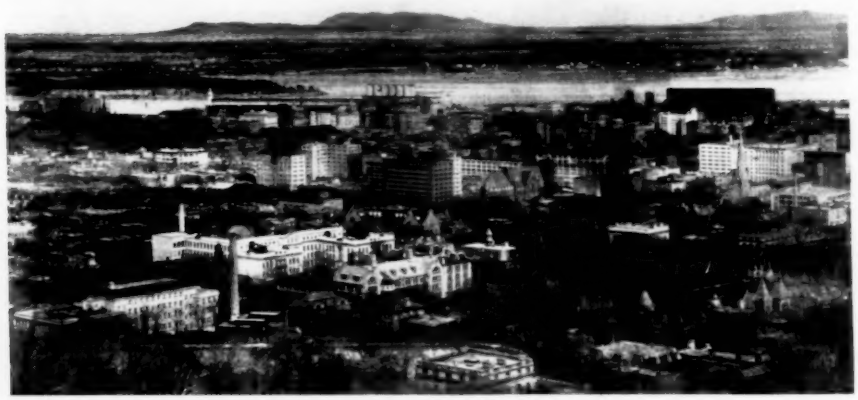
EDITORIALS

AMERICAN ROENTGEN RAY SOCIETY

ANNUAL MEETING IN MONTREAL

THE convention of the American Roentgen Ray Society to be held in Montreal September 20–23 inclusive is an event of more than ordinary interest to the members, their families and their friends, for the occasion offers the opportunity to combine scientific and technical deliberations of high value with a recreational experience of novelty and rare enjoyment.



View from Mt. Royal.

From the top of Mt. Royal are obtained glorious views of the encircling city, the majestic St. Lawrence and its tributary the Ottawa, Lake St. Louis and Lake of Two Mountains, and on clear days the Laurentians to the north and the White and Green Mountains and the Adirondacks to the south.

Montreal is a city to whose charm all visitors quickly surrender, and they depart reluctantly, enthusiastic in their praise of its unique attractions and resolved to come again. No other community in North America can duplicate its blend of modernity and historical interest, for it was the fount of civilization and religion for half the continent, including a great part of what are now the Middle Western States of the Union. There still stand in the narrow, crooked streets of the older portion of the city buildings two to three hundred years old, some of them the residences for a time of the men who were pioneers in the exploration of the Great Lakes and the Mississippi Valley and founders of cities—Detroit, Duluth, Sault St. Marie, Marquette and Joliet—which perpetuate the names or the mother tongue of the dauntless adventurers or martyr missionaries of French Canada who made Montreal the rendezvous and starting point for their journeys into the unknown wilderness. Where the actual buildings associated with these immortal figures have disappeared, their sites are marked for future generations.

The scant half-mile square which was the original city of Ville Marie is packed

with memorials and recollections of the storied past. On Place d'Armes, which marks the center of the old city, is a monument which marks the spot where the founder, Paul Chomedy de Maissonneuve, slew with his own hand the chief of an attacking band of Iroquois. On the south modest house and garden of Daniel de Gresolon, Sieur de Lhut (also known as Dulhud and Duluth), who gave his name to the Lake Superior city which he founded. Two blocks to the east is the Chateau de Ramezay, erected in 1705, the official residence of the governors of both the

Notre Dame Church.

Here Notre Dame Church, 100 years old, and the Seminary of St. Sulpice built in 1685, stand side by side with banks and office buildings looking down on the spot where Paul Chomedy de Maisonneuve, founder of Montreal, with his own hand slew an invading Iroquois chief.

of the square stands the historic Church of Notre Dame, erected over one hundred and ten years ago to replace another built nearly one hundred years earlier. Flanking the church on one side is the actual fabric of the Seminary of St. Sulpice, built in 1685, and on the other is an office building erected on property once occupied by the French and English regimes, and the headquarters of the American army of occupation in 1775. Here Benjamin Franklin and his fellow-commissioners, Carroll and Chase, stayed when they came to Montreal on their fruitless mission of persuading the French-Canadians to throw in their lot with the American revolu-

tionary cause. Nearby is the little stone house in which General Montgomery spent the winter before he set out on his fatal attempt to capture Quebec for the Americans, and a few yards distant is the spot where LaSalle lived just before he undertook the expedition on which he discovered and voyaged down the Mississippi.

These are but a few of the myriad associations which link Montreal indissolubly with the interwoven history of the struggle of three great peoples—British, French and Americans—for the possession of the continent of North America. They should suffice to assure the delegates to the American Roentgen Ray Society convention that in Montreal will be found a host of interesting sights and scenes that will make their visit a pleasant experience and a life-long memory.

Chateau de Ramezay.
Erected in 1705, residence of the French and English governors of colonial Canada, and now a museum.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Charles L. Martin, Dallas, Texas.
Twenty-eighth annual meeting, Montreal, Can., Sept. 20–23, 1927.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Minneapolis, Minn., 1928.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.
Annual meeting, New Orleans, La., Nov. 28-Dec. 2, 1927.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. E. C. Samuel, New Orleans, La.
Annual meeting, Memphis, Tenn., Nov. 14–17, 1927.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. Henry L. Ulbrich, 1130 E. Grand Blvd.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. W. W. Belden, 8 West 16th St.
Meets monthly on second Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. C. Davidson, Highland Hospital.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. Davis Spangler, Dallas, Texas.
Meets annually.

British Empire

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

*Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S. G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1928.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. H. Scheuermann, Copenhagen
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

VIENNA LETTER

(From our special correspondent)

ROENTGEN RAYS WHICH COME FROM THE SKY

The Austrian scientist, Hess, was first to discover and establish the existence of those novel, invisible rays which were named "celestial x-rays" by the great French physicist D'Arsonval, and the nature of which has been clarified by measurements by the American physicist, Millikan. Quite recently Kohlhörster, a a German research worker, made extensive investigations of these rays and proved that they have a penetrating power a hundred times greater than roentgen rays. They are ultra-roentgen rays which can penetrate a block of lead 2 meters thick. His observations revealed the fact that the intensity of these rays which is particularly great in the higher regions of the atmosphere is the same day and night. This, of course, refutes the assumption that these rays are emitted by the sun. The conjecture that the radioactive substances of the earth have some part in their production has also been shaken by these observations. The observations, in fact, point to a quite different source of the "celestial rays" which according to the opinion of Kohlhörster are emitted by the star gangs of the milky way and by those worlds in the act of formation which light up the firmanent as light clouds, known to astronomers as cosmic fog. Since this cosmic fog displays milky way systems identical to that to which our own sun empire belongs, the "celestial rays" may be assumed to be heralders of other world islands which are several hundred thousand light years distant from us

This beautiful theory has been contested by the celebrated American meteorologist Wilson and his English confrère Simpson. According to them the rays in question do not originate from the sun nor from the atmospheric cloak of the earth but are produced by lightnings. According to Wilson, as set forth in the Vienna Physical Society at a recent scientific meeting, there are about 1800 storms in every second on the earth with an average of 100 lightnings. The energy of these lightnings represents about a billion watts which produce a whirl of electrons which could cause the ultra-roentgen rays in question. It was asserted in the Physical Society that Wilson's views will quite certainly be contested. James, an Englishman, has brought forth a very interesting and ingenious hypothesis

which assumes that these cosmic rays are the result of a natural destruction of atoms which takes place in the interior of distant stars. Through this process an immense quantity of energy is liberated which flows in the world spaces. Such a destruction of atoms is taking place constantly in our own sun, but since the sun belongs to an older generation and as its texture is much firmer than that of young stars, the radiations produced in the sun lose much of their energy in reaching the surface and could never be possessed of the power to penetrate a lead block 2 meters thick when they arrive in our atmosphere.

ON THE IMPORTANCE OF REPEATED ROENTGEN-RAY EXAMINATIONS OF PATIENTS WITH PULMONARY TUBERCULOSIS

Haudek, lecturer to the University of Vienna, expresses the view that single screen examinations are very unreliable as a basis for judgment of the anatomical character of tuberculous changes in the lungs. A series of observations with both screen and roentgenogram at short intervals gives much more valuable diagnostic criteria. Serial roentgenograms are particularly important in cases in which the first examination reveals indefinite, poorly defined areas of apparent infiltration. Such appearances are often due to localized pneumonias which have no tendency to caseation or breaking down and may disappear after several weeks or even months. Their end results, pleural adhesions and thickened bronchial markings, strongly remind one of the products of inflammations. The tendency of tuberculosis to heal spontaneously is emphasized by series of roentgenological observations where cavities of considerable size are seen to disappear after hospital treatment for several months without the employment of surgical therapy. The indefinitely outlined infiltrations mentioned above may be seen not only in cases of lobar and lobular pneumonic thickenings, which in most cases are of bronchogenic origin, but also in cases of hematogenous dissemination. These latter may be present for only a few days, hence the importance of frequent roentgenological examinations.

FURTHER EXPERIMENTS WITH THE ROENTGEN-RAY TREATMENT OF SUPPURATIVE PROCESSES

In a recent lecture, Professor Holzknecht of Vienna gave an account of experiments of his own and of Pordes, Rosenbaum, and Borak of Vienna, and of Heidenhain, and Fried of Worms, Germany, which have shown that in acute and subacute coccus infections treatment by the roentgen ray has a very beneficial action upon the suppurative process in the majority of cases. With present technique it is possible to influence favorably two-thirds of the cases of phlegmon, abscesses of the extremities, trunk and neck, parametritis and suppurations following operations. Suppurations of the face and nasal accessory sinuses do not show any tendency to heal. The treatment is partly roentgen therapy and partly surgical. The treatment is begun with a ray of medium penetration, giving a dose varying from $\frac{1}{2}$ to 2H. The beneficial effect is evident after six to eight days. In some cases the favorable action is evident on the first day, inasmuch as fever, pain and swelling may be reduced. The treatment may result in resolution or in fusing of the suppurative processes. The latter seldom perforate spontaneously but must be evacuated surgically. Holzknecht agrees with Heidenhain who says, "Do not incise before irradiation. Do not be alarmed even by lymphangitis." From a serological point of view irradiation is followed by an increase in bacteriolysis through four to six days. Sterile pus, which is otherwise of very infrequent occurrence, is often met with after irradiation. Explanations of the action of the roentgen rays are divergent. According to Pordes the effect is attributable to the destructive action of the rays upon the highly sensitive leucocytes of the infiltrate and the liberation of antitoxins and bacterolysins present in them.

AN EYE SAVING DEVICE FOR USE IN ROENTGENOSCOPIC EXAMINATIONS

Close attention to details on the roentgenoscopic screen often results in eye strain. This is due, at least in part, to the fact that the distance between the screen

and the observer's eyes is small. This is particularly noticeable in examinations of the duodenal bulb. Some observers when closely scrutinizing the bulb often have the eyes not further than 5 or 6 inches from the screen, and often close one eye in an involuntary effort to rest the eyes. It is the convergent movement and accommodation of the eyes which contribute most of the eye strain. The convergent movement can be relieved only by placing two prisms in the path of the rays. Dr. Staunig devised a pair of spectacles in which he places two prisms combined with convex lenses capable of eliminating the over-strain caused by excessive accommodation and convergence. By the use of this apparatus the image on the screen appears much sharper, clearer and richer in details and is also magnified. The apparatus is so constructed that it may be adapted to any fluorescent screen and carries a small gear which enables the user to adapt it to his individual refraction and the distance between the pupils. Professor Holzknecht is using the apparatus with satisfaction.

JAPANESE ROENTGEN SOCIETY

The Fifth Annual Meeting of the Japanese Roentgen Society, whose president is Dr. Koshiro Iwasaki, was held on April 1, 1927, Kyoto Imperial University Medical School. Some of the subjects discussed at the meeting were as follows:

"Effect of Roentgen Irradiation upon the Excretion of Dye" by N. Hayashi. Dr. Hayashi injected phenolsulphonphthalein into rabbits after they were irradiated, the liver region being protected, and he found decreased excretory function of the kidney on the first day after such irradiation, and gradual return to normal on the second day. This change is not considered as due to the functional disturbance of the kidney according to the indications of their control animals.

T. Watanabe reported on "Some Biological Effects of Roentgen Irradiation upon the Tissue." He exposed the liver of bled rabbits to roentgen radiation and measured the total nitrogen and nonprotein nitrogen content of the liver. He found an increase of the latter over that of the control. Then he injected peptone and histamine into the rabbits before they were bled, followed by a similar experiment on the liver. He found that there was a much greater increase of nonprotein nitrogen than in the preceding experiment.

N. Yanagisawa gave his roentgenological findings in the stomachs of breast fed infants. He made a roentgenological study of the gastric function in 130 Japanese breast fed infants whose ages varied from four hours to one year. He found that the position, tonicity, construction and other functions as brought out by this study agree in general with the findings of both American and European investigators. He also made a detailed roentgenological study of the stomachs of so-called "infantile beriberi of the breast fed" which is endemic in Japan.

G. Goto discussed the "Radiation Effect upon Reticulo-endothelial Cells." He injected carmine solution into the rat to which he applied various doses of roentgen rays, just before or after such an injection, and made histological study of endothelial cells of the reticular system as to the ingestion of the coloring substance by these cells. He found functional disturbance in all these cells in the liver, spleen, bone marrow and lymph nodes toward the ingestion of the dye substance, as the result of irradiation. The total amount of the ingested coloring matter varies according to the time elapsed after the irradiation, as well as the time elapsed after the injection and the amount of the dye injected.

K. Mawatari and others reported their clinical findings in cases of peritoneal tuberculosis which were treated by roentgen irradiation. They stated that cases with ascites responded more favorably to hard rays, while the nodular type responded better to rays of softer quality.

I. Igarashi gave a report on twenty cases of sarcoma treated by deep roentgen irradiation.

EDWARD E. YOSHII.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

SOME NEW METHODS IN ROENTGENOGRAPHY*

BY WALTER ALTSCHUL, M.D.

German University of Prague (Clinic of Professor Schloffer)

PRAGUE, CZECHOSLOVAKIA

THE War and it sequelae have brought about an interruption in the scientific relations between the various countries. As a result each nation has had to rely more or less upon its own literature, and foreign works could not be consulted to the extent previously possible. This condition is quite apparent in the roentgenological literature of recent years. It was only at the recent International Congress in London that the situation was changed and opportunity was afforded for a *rapprochement* of the roentgenologists from different countries. The various journals, moreover, publish extensive reviews of foreign literature; but since an abstract cannot take the place of the original work, it would be desirable and at the same time would greatly further the development of roentgenology if papers of general interest were republished in foreign journals.

I am therefore taking the opportunity of briefly reporting in the following pages certain new methods of roentgenography which I have published *in extenso* in German journals during the past few years, and to recommend their employment, because these methods have proven entirely satisfactory in our clinic.

1. THE DEMONSTRATION OF THE TEMPOROMAXILLARY JOINT[1]

While the problem of roentgenography of the mandible, i.e., the horizontal ramus, appears to be solved by the various methods of oblique exposure from the neck, the roentgenography of the temporomaxillary joint has remained unsatisfactory. In the oblique exposures from the neck, the shadow of the maxillary joint appears too much distorted; hence to avoid this, it has been suggested that roentgenograms of this joint be taken through the open mouth (Algyogyi. Wiesner) or through the semilunar notch with the mouth open (Gocht, Bauer).

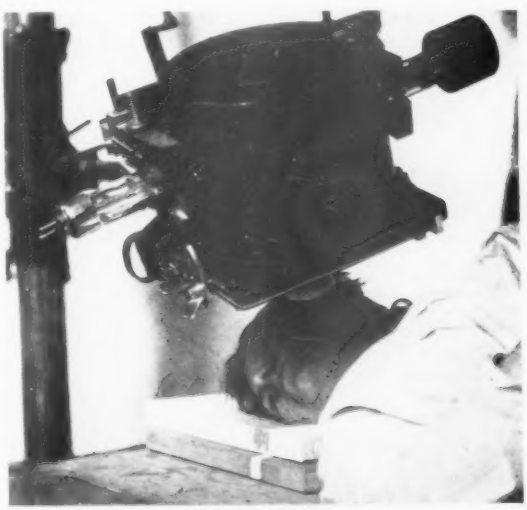


FIG. 1. Arrangement for roentgenography of the temporomaxillary joint.

For roentgenograms of this sort, one must count on the possibility of opening the mouth of the patient, but the usual reason in the majority of cases for roentgenographing the temporomaxillary joint is some form of ankylosis or other processes (for instance, fractures) in which opening of the mouth is impossible. The above methods, therefore, can yield useful pictures only of healthy or almost healthy maxillary joints, but they are unable to yield them in cases of pathologically altered joints, precisely those cases in

[1] Published in *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1919–20, xxvii, 23–28.

* Translated from the German by B. Cohen, PH.D., Washington, D. C.

which they are usually most needed. I have therefore devised a method which is capable of being carried out upon any patient under simple and convenient posture, and which yields unobjectionable pictures of the maxillary joint free from distortion and from superposition.

If a sound (to represent the central beam) is placed in the plane of the maxillary joint of a macerated skull and if it is pointed so as to avoid projection into any of the covering bony portions, it will be found that the central ray will have to pass through the center of the base of the coronoid process of the opposite half of the mandible in order to yield a satisfactory picture. In this connection, one must take into consideration the fact that the roentgen rays will have to traverse this opposite half of the mandible. When, however, a short funnel is employed in order to approach the tube to the jaw as closely as possible, the shadow of the half of the mandible furthest from the plate (owing to its greater distance from the plate and shorter distance from the focus) will be very much enlarged, and will appear so thinned out as to be practically invisible in the roentgenograms taken by this method.

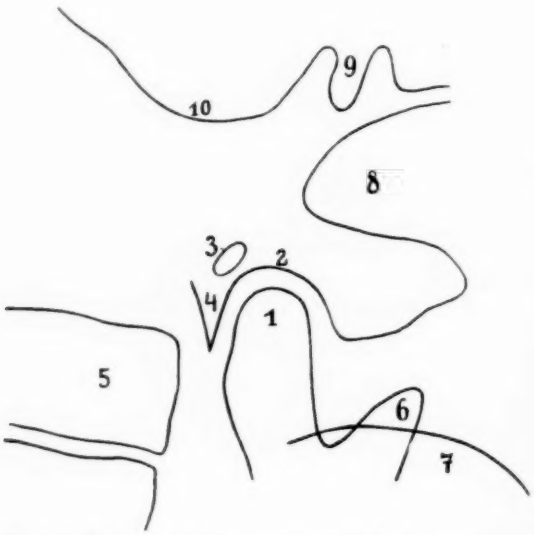


Fig. 2. Diagram of the temporomaxillary roentgenogram. 1. Capitulum. 2. Acetabulum. 3. Auditory canal. 4. Styloid process. 5. Vertebral column. 6. Mandibular coronoid process. 7. Gums. 8. Orbit. 9. Sella. 10. Base of the posterior cranial fossa.

The roentgenogram is taken as follows: The patient is placed in an exactly lateral, recumbent position so that the maxillary joint lies just upon the middle of a small plate (9 × 12 cm. is sufficient). A funnel of 5 cm. diameter and 8 cm. length is placed with its center over the base of the coronoid process of the opposite side, and it is so adjusted that the axis (central ray) is pointed toward the maxillary joint to be roentgenographed. To accomplish this,

Fig. 3. Arrangement for roentgenography of the auditory system.

it is necessary to tilt the cone caudocranially about 25° and fronto-occipitally about 20°. The correct point to which the central ray must be directed is easily found: it is the intersection of the horizontal line running through the point of insertion of the ear lobule and the line connecting the angle of the jaw with the lowest point on the frontal margin of the scalp.

Figure 1 indicates the method of roentgenographing. Figure 2 gives schematically the details of the roentgenogram thus obtained.

II. THE SURVEY ROENTGENOGRAM OF THE AUDITORY SYSTEM[1]

There are quite a number of methods published for roentgenographing the ear, but these are useful for visualizing only certain portions of the ear (Sonnenkalb, Schüller, Stenvers, Sgalitzer, Mayer and others). It is therefore necessary to make a large number of exposures in order to get a precise idea of the changes present in the auditory system, especially if one has to take comparison roentgenograms of the healthy side also. Since the necessary adjustment is usually tedious, such an examination of the ear requires considerable time and is quite complicated. The survey roentgenograms hitherto employed (the anteroposterior exposure with projection of the pyramids in the orbits, the ordinary posteroanterior roentgenogram, and finally the axial roentgenogram of the base of the skull) do not yield a general picture of the whole region and can be used only for rough orientation. I therefore set about to find a roentgenographic technique which would permit the representation upon a *single* plate of both ears in their entire extent and symmetrically arranged; and I have succeeded in discovering a suitable position for producing such pictures.

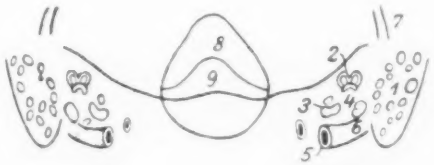


FIG. 4. Schematic outline of the roentgenogram of the ear. 1. Mastoid process. 2. Semicircular canals. 3. Cochlea. 4. Tympanic cavity. 5. Bulbus venae jugularis. 6. Sinus transversus. 7. Sinus sigmoideus. 8. Occipital foramen. 9. Arch of the atlas.

The roentgenogram is obtained as follows: The patient is placed in the supine position with the head bent forward as far as possible so as to bring the chin against the chest. The head must of course be supported by means of a pillow suitably placed underneath. The central ray enters at the point marking the limit between the anterior and middle thirds of the line drawn in the median plane of the skull and connecting the root of the nose with the occipital protuberance. This point lies two or three finger widths back of the frontal boundary of the scalp. The central ray is directed toward the center of the occipital foramen; and the cone must be tilted about 40° craniocaudally. The roentgenogram is best taken with fairly hard rays in conjunction with a Bucky diaphragm.

Figure 3 shows the arrangement; and Figure 4 gives a schematic representation of the details of a roentgenogram made by this method. Figure 5 shows a bilateral otitis with destruction of the cells of the right mastoid; and Figure 6 shows the condition after several operations for sinus thrombosis (there is entire absence of the mastoid, of the squamous portion of the temporal bone and of the tympanic cavity).

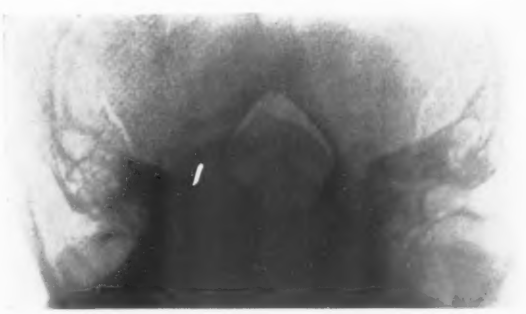


FIG. 5. Bilateral otitis. Increase in density of the pyramids on the left; destruction of the mastoid cells on the right.

FIG. 6. Operative defect of the squamous portion of the temporal bone, of the mastoid process and of the antrum on the left side.

[1] Published in *Ztschr. f. Hals-Nasen u. Ohrenheilk.*, 1926, xiv.

III. THE AXIAL ROENTGENOGRAM OF THE PATELLA[1]

While the patella can be satisfactorily visualized in the lateral view, it shows up either indistinctly or not at all in the sagittal view. It is, however, important to secure a roentgenogram with the rays directed axially in order to comply with the well-recognized principle of obtaining two roentgenograms of bone lesions in planes at right angles to each other. The methods heretofore proposed for the axial roentgenography of the patella have the

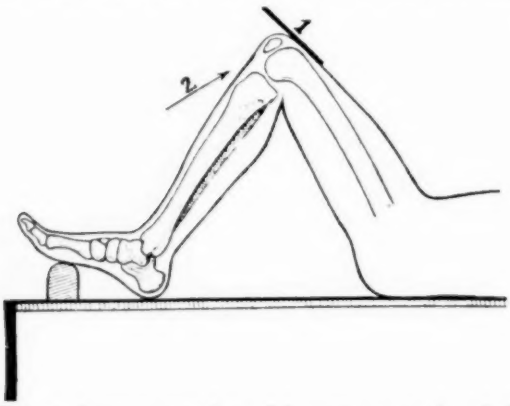


FIG. 7. Arrangement for axial roentgenography of the patella (schematic). 1. Plate. 2. Central ray.

disadvantage which I have already discussed in the case of roentgenography of the temporomaxillary joint, namely, they are possible only in healthy or almost healthy knees, because they require maximal flexion.

My procedure is as follows: The patient is placed on his back and he flexes his knee as far as he is able. The foot is then supported close to the end of the roentgenographic table. The plate is placed on the extensor surface of the femur, held in position by the patient, if possible, and the tube is so adjusted that the central ray traverses the patella caudocranially. In cases of maximal flexion the roentgen tube can be approached quite close to the joint; the less the degree of flexion the farther away will the tube have to be placed. Some degree of flexion is naturally necessary; but I have been able to secure good pictures by this method even with an angle of flexion of only 120°.

[1] Published in *Verhandl. d. deutsch. Röntg.-Gesellsch.*, 1924, xv.

The study of the axial roentgenograms yielded a surprising number of pathological findings; and in some cases it was only the axial picture that disclosed changes in the knee joint under examination. The clinical observations have been published by Dr. Jaroschy, orthopedic assistant in this clinic. He found arthritic dentation and also, especially in habitual patellar luxations without evidence of arthritis, there were discovered ossifications near the patella, apparently in the region of the retinacula.

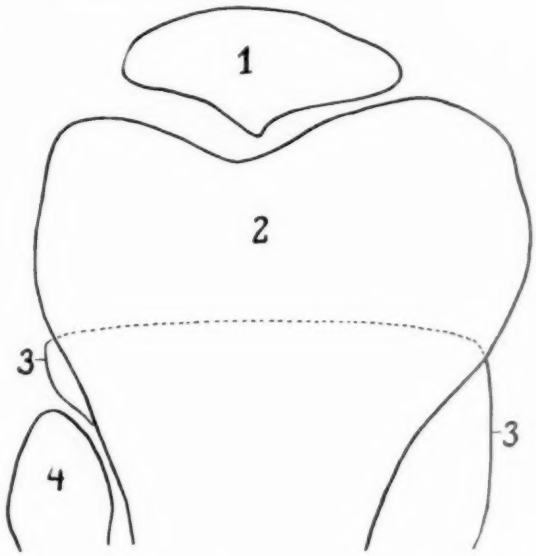


FIG. 8. Schematic view of the axial roentgenogram of the patella: (1) patella; (2) femur; (3) tibia; (4) fibula.

Figure 7 shows the arrangement for roentgenography; Figure 8 gives schematically the details of the roentgenogram; Figure 9 shows arthritic changes in the patella; and Figure 10 shows ossifications in the retinacula in a case of habitual patellar luxation.

IV. METHOD FOR THE LOCALIZATION OF INTRA-OCULAR FOREIGN BODIES[1]

For the localization of intra-ocular foreign bodies we have available various methods which may be classed in two groups: (1) the so-called *geometrical* methods, in which the position of the bulbus remains unchanged, and the localiza-

[1] Published in *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1922, xxix, 441–464.

tion is established by shifting of the roentgen tube; and (2) the so-called *physiological* methods in which the position of the roentgen tube remains stationary and the roentgenograms are taken with the eye sighting in different directions.

Each of these groups has its advantages and disadvantages. The advantages of the physiological method over the geometrical are as follows: (1) it enables one to determine the *center of rotation* of the eye, whereas the geometrical method merely indicates the relation of the foreign body to the corneal vertex; (2) moreover, with the aid of a corneal or a scleral mark, the physiological method can locate the corneal vertex and thus permit one to obtain a picture of the bulbus in actual size; (3) the fact that the method checks itself automatically makes it possible to avoid errors in localization.

Opposed to the above we find the following disadvantages: (1) In the physiological procedure more roentgenograms have to be taken than by the geometric method; (2) the reading of the details in the physiological method is more complicated, and the determination is much more difficult than in the geometric method: (3) the physiological method is applicable only when the vision of at least *one* eye is retained. It is very seldom, however, that the vision in both eyes is lost. (4) In the physiological method the movements of the foreign body are actually smaller than indicated on the plate. This "magnification error" affects the accuracy of localization; however, this error can be corrected by calculation.

If now we balance the advantages and disadvantages, we come to the following conclusion: If it were possible to simplify the reading of the details and the interpretation of the findings, and to reduce the magnification error to a minimum the advantage would be all in favor of the physiological method. Since, however, the physiological methods hitherto employed, as exemplified by the methods of Holzknecht and of Belot, do not satisfy these requirements, it is evident that the preference will be in favor of the simpler geometrical methods, e.g., the American method of Sweet.

However, for the reasons enumerated above I regard the physiological methods as being better, and I have sought to eliminate their disadvantages so far as possible. As a result the following procedure was devised: First, I constructed a sliding cassette that enables the taking of six roentgenograms upon different portions of one 13 × 18 plate. Upon this cassette there is mounted an arrangement (see Fig. 12) carrying four fixed sighting points for vision straight in front, downward, upward and nasally. A fifth sighting point for temporal vision is brought to the correct position upon the cassette cover by means of a slide adjusted according to the distance between the corneal vertex and the top of the cassette. These five sighting points are so arranged that the line connecting the center of the eye and the sight for forward vision forms an angle of 30° with each of the lines connecting the center of the eye with the other four sights. Figures 11 and 12 illustrate

FIG. 9. Arthritis. Left: normal picture. Right: marginal elevation on the external side of the patella projecting over the external condyle.

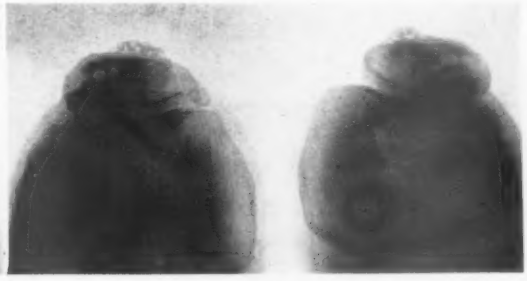


FIG. 10. Habitual patellar luxation. Left: ossification in the median retinaculum. Deposits on the anterior aspect of each patella.

the arrangement, and for a fuller description the reader is referred to the more detailed original paper.

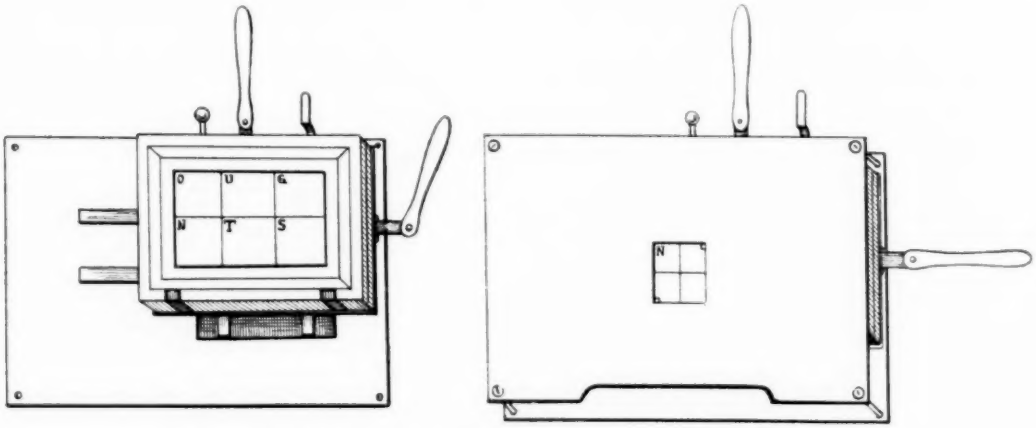


FIG. 11. Sliding cassette. 1. With cover removed. 2. Ready for use.

The arrangement permits the taking of five roentgenograms while sighting directly forward, downward, upward, nasally and temporally at a constant angle of rotation of 30°. Upon the sixth unexposed portion of the plate, a roentgenogram is taken of the eye without any special direction of vision after making a scleral marking (with staniol). Figure 13 shows the general arrangement for roentgenography. This finishes the examination, and after development of the plate comes the determination of the result. In order to simplify this, I have employed a mathematical device based on the choice of the 30° angle of rotation. First, there is determined the distance of the foreign body from the median sagittal plane of the eye. If we call this distance a, the angle of rotation of the eye at each change α, and the projection of the foreign body movement upon the plate when changing the direction of vision from the temporal side to the nasal p, the following relationship is obtained:

$$a = \frac{p}{2 \sin \alpha}$$

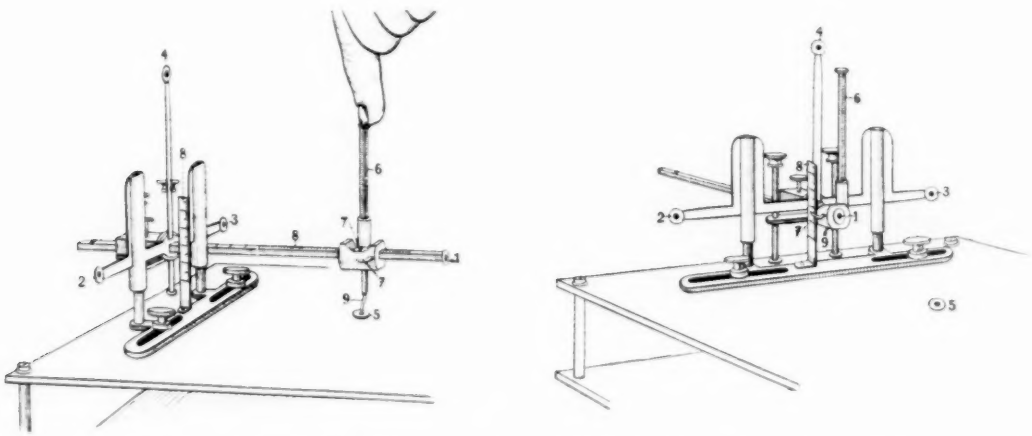


FIG. 12. Arrangement for fixing direction of vision. I. Adjusting the sight (5) for "temporal" vision. II. Ready for roentgenography. 1. Sight for forward vision. 2. Sight for downward vision. 3. Sight for upward vision. 4. Sight for nasal vision. 5. Sight for temporal vision. 6. Rod with sliding catch. 7. Pointers, and 8, scales for adjustment of the "temporal" sighting point. 9. Foot of the sliding rod.

By selecting the 30° angle this equation becomes simplified since sin 30° = ½. Therefore, $a = p$. This means that no calculation is necessary since the distance between the shadows of the foreign body in the temporal and nasal sightings is equal to the sought distance of the foreign body from the median sagittal plane of the eye.

In order to determine the distances from the frontal median plane and the horizontal median plane, there are required roentgenograms of the foreign body taken while

FIG. 13. Roentgenographic arrangement for localization of foreign body.

sighting upward and downward respectively. Since, however, we now have points which lie in a plane different from that containing the first determined point, we must project the new shadows upon a line which naturally must be parallel to the plane of reference. The distance between the foreign body shadows produced in the upward and downward sightings is therefore projected upon the *lateral* edge of the plate, and this projection is equal to the distance of the foreign body from the frontal median plane. The projection of this distance on the *upper* or *lower* edges of the plate equals the distance of the foreign body from the horizontal median plane.

To make the analysis, one first transfers the five shadows of the foreign body and the shadow of the scleral marking to a glass plate ruled in millimeter cross sections (Fig. 14). Next, the distances of the foreign body from the three main planes drawn through the rotational center of the eye are determined as follows: the distance, a, of the foreign body from the sagittal plane is equal to the distance between the foreign body shadows produced by nasal and temporal sighting (a = NT = 3 mm.); the distance, b, from the frontal plane is

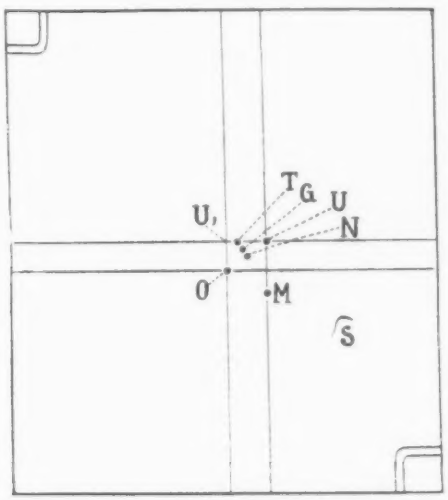


FIG. 14. Example of foreign body localization. Shadows of the foreign body on the plate: O, when sighting upward; U, when sighting downward; N, in nasal sighting; T, in temporal sighting; G, directly forward. M, projection of the frontal axis of the eye. U_1U, projection of OU on the upper edge of the plate. OU_1 projection of OU upon the lateral edge of the plate; S, scleral marking.

equal to the distance between the two horizontal lines in the ruled plate corresponding to the upper and lower positions of the foreign body shadow ($b = OU_1$ = 4 mm.); and the distance, c, from the horizontal plane is equal to the distance between the two vertical lines in the ruled plate which run through the upward and downward positions of the foreign body shadow ($c = UU_1$ = 5.7 mm.).

If an equilateral triangle is constructed upon the line marking the distance between the upper and lower positions of the foreign body shadow, the third apex, M, in Figure 14, is the projection of the frontal axis and

therefore also of the center of rotation upon the plate.

The distance, r_1, of the foreign body from the frontal axis in the plane of the foreign body is therefore equal to the distance between the upper and lower positions of the foreign body shadow (r_1 = OU = ⁻ mm.).

The radius, R, of the eye, is equal to the distance of the shadow of the scleral marking from the point M (R = SM = 11.5 mm.).

These five values are obtained by the direct measurement of the various distances and without any calculation.

It is, however, possible now by means of a simple calculation to determine the distance of the foreign body from the center of rotation and from the nearest point on the surface of the eyeball. The distance from the center is: $\rho = \sqrt{r_1^2 + a^2}$ and the distance of the foreign body from the nearest point on the surface is $R - \rho$.

The possibility of being able to determine this *nearest point to the surface* is, in my opinion, the greatest advantage of my procedure, since this is the point from which the extraction of the foreign body will have to be undertaken. It is determined by two angles, namely, (1) the angle (δ) formed by the radius drawn through this point and the projection of this radius upon the horizontal median plane; and (2) by the angle (ϵ) which this projection forms with the sagittal axis. The equations for these angles are as follows:

$$\sin \delta = \frac{c}{\rho}, \text{ and } \tan \epsilon = \frac{a}{b}.$$

The determination of these angles is made with the aid of trigonometric tables; in order to avoid these calculations I have determined the angles for certain values of c and ρ and of a and b, and I have compiled them in two tables which were published in the original paper. In the example given above the value for δ is found to be 48°, and for ϵ, 3⁻°.

The disadvantages of the physiological method are entirely avoided by my method. Only one small plate is required for all the exposures; and the time required is moreover not very great. It takes me about two minutes for all six roentgenograms, including the time for shifting the cassette. As regards the magnification error, I have calculated in the original paper a correction factor which has been employed in various determinations. The differences between the corrected and uncorrected values amount to but a few tenths of a millimeter, so that it is not absolutely necessary to apply the correction. The individual readings and the final analysis are extraordinarily simple, perhaps even simpler than in any of the other methods proposed. At the same time, this method yields much more information, since it reveals the relations of the foreign body not only to the three main planes of the eye but also to its center and to the nearest point on the surface (something which has been impossible with any other previous method and which, as mentioned above, I regard as the greatest advantage of my procedure).

This method has been employed in the German Ophthalmologic Clinic in Prague (Prof. Elschnig) and my experience with it has been entirely satisfactory, justifying the belief that the procedure is really an improvement over other methods.

Vol. XVII, No. 6

APPARATUS FOR MAKING ROENTGEN-RAY DOSAGE MEASUREMENTS*

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NEW YORK CITY

THE rate of ionization of air in a properly designed and calibrated chamber is generally considered to be the best index that we have of the dosage of roentgen rays used for therapy. The habit of making such measurements has not spread very rapidly, however, one of the reasons being, presumably, that no standard equipment is available which is accurate and reliable, and at the same time simple, compact, and conveniently portable.

When the target distance is great or when it is desired simply to check the constancy of output of a tube, a large ionization chamber may be used and the current may be measured by means of a very sensitive galvanometer. On the other hand, one must use a small chamber to measure the rate of ionization at a point, approximately, and to integrate the effects of direct and secondary radiation. This means a small current and the use of an electroscope or an electrometer. Ideally, the chamber would be connected with the electroscope by means of a flexible conductor so that it could be moved and adjusted to any desired position without the necessity of moving, readjusting, and checking the electroscope. How to construct a properly insulated and protected flexible conductor is an unsolved problem, unfortunately.

It occurred to me some time ago that if the chamber were connected permanently to a small condenser in such a manner as to make a simple compact unit, this unit might be disconnected from the electroscope for the duration of the exposure to the rays, and returned to it afterwards for a measurement of the amount of charge lost. It would be possible, thus, to do away with the flexible conductor entirely. The single obvious disadvantage is that one would have to estimate the length of exposure of the chamber in advance; it will appear further on that this need give little trouble in practice.

Apparatus of this kind has been made and used, and it has been found to work very nicely. The particular instrument which I shall describe was designed to measure the relatively soft rays produced at from 30 to 100 kv. peak. It represents, of course, merely a first attempt to solve the problem; several changes will be made when it is reconstructed.

DESCRIPTION OF THE INSTRUMENT

Figure 1 shows the apparatus completely assembled; in Figure 2 some of the parts have been removed in order to show the essential features of the internal construction; *a* is the chamber unit; the rest will be called the electroscope.

The Electroscope. The insulated element of this unit comprises the gold leaf and its support, *b*, the upper set of plates, *c*, of a variable condenser, and the device, *d*, by means of which a connection may be established with the inner electrode of the chamber unit; it is mounted on a single amber insulator, *e*, so shaped as to insure that the apparatus can be taken apart and reassembled without changing the capacity of the condenser; *d* is merely a pin, the head of which is supported on a light helical spring. The sensitiveness of the gold leaf may be adjusted by means of the screws, *f*. By turning the button, *g*, one connects the insulated element with a charging battery—~ 45-volt B-batteries. The lower set of plates, *h*, of the condenser, is connected with the case; it is fed up or down by means of a screw attached to the drum, *i*. The capacity scale on the drum was drawn after a very careful experimental study of the condenser. The travel of the drum is limited at both ends by means of stops. The capacity change is about 6~.5 cm.

The Chamber Unit. This unit, which consists of a small chamber and a condenser, is shown connected with the electroscope at *a* in Figure 1 and separately, at *a* in Figure 2. The condenser consists of a small

* From the Laboratories of the Rockefeller Institute for Medical Research.

brass cylinder supported axially inside the brass tube which constitutes the visible body of the unit. The inner cylinder is $1\frac{1}{2}''$ long and $\frac{3}{8}''$ in diameter; it is mounted on amber at either end. The outer tube is $2\frac{3}{4}''$ long, and $\frac{3}{4}''$ in external diameter; the diameter of the hole exceeds that of the inner cylinder by only 0.01".

The ionization chamber is of pure graphite. The outer shell is about 0.01" in thickness, the inner diameter being $\frac{3}{16}''$; the inner electrode is a graphite rod $\frac{1}{16}''$ in diameter. The amber extends to the middle of that part of the graphite shell which is visible in the illustrations; the air space in the chamber is thus only about $\frac{5}{8}''$ long.

The end of the condenser opposite to the chamber may be closed by means of the screw, *j*, the length of which is such that it very nearly makes contact with the inner cylinder. In this end of the inner cylinder, there is a small conical depression, carefully centered; it serves to center the needle, *d*, when the chamber unit is being connected to the electroscope. A stop is provided in the tube, *k*, of the electroscope to limit the depth to which the chamber unit may be inserted. The connection is made in exactly the same way every time, therefore, however carelessly the chamber unit may be inserted.

The electrostatic capacity of the chamber unit is ~0 cm.

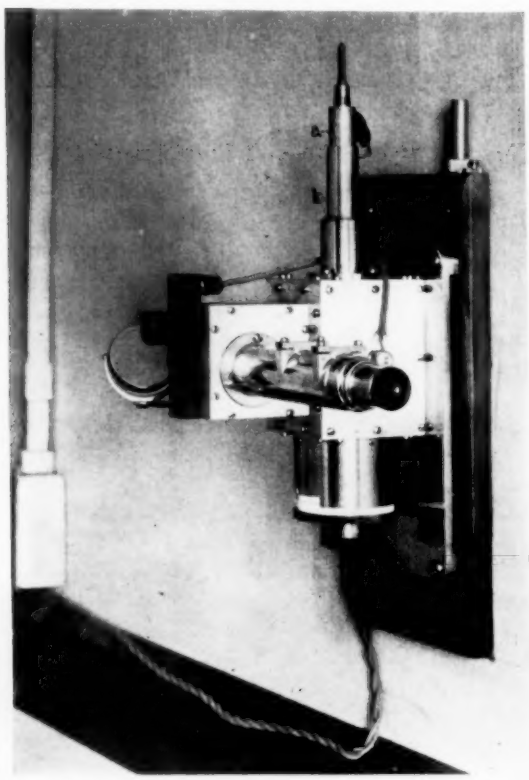

FIG. 1. The apparatus completely assembled.

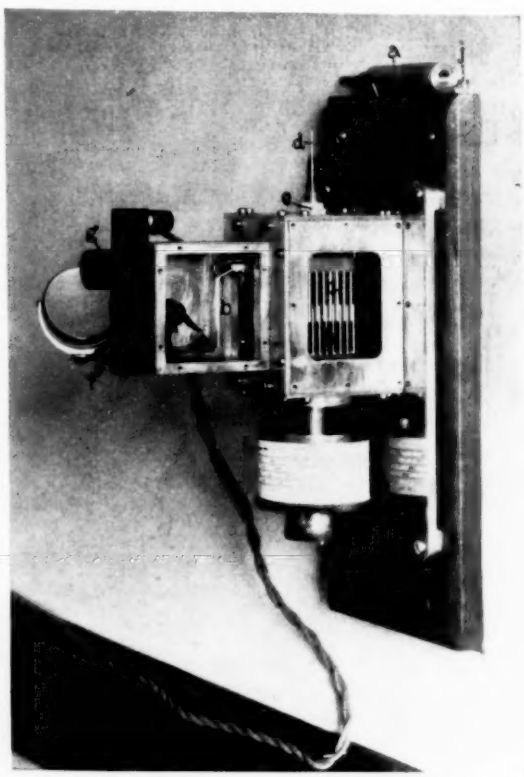

FIG. 2. Showing the internal construction of the electroscope.

The volume of the air space in the condenser is about one-half as great as that in the chamber proper. It is protected from the rays by $\frac{3}{16}''$ of brass, however, so the leak is negligible for rays no harder than ~0 kv. When very hard rays are used the condenser must be protected with lead. There is no good reason why the air space in the condenser may not be made much smaller, nor in fact any reason why the whole unit may not be reduced in size.

No stress is put on the design of the chamber itself. Beyond allowing the amber

to extend far enough into the graphite so that the brass would not cast shadows on the chamber at reasonable angles, it was attempted only to make the chamber of such shape that it could be saturated easily, and to make it light and thin enough to transmit very soft rays. The chamber could be improved without doubt; before rebuilding it, I intend to study the behavior of beryllium as a substitute for the graphite.

The range of usefulness of the instrument could be extended, of course, by providing several chamber units, each adapted to a particular range of intensity and wave length.

HOW MEASUREMENTS ARE MADE

With the chamber unit connected to the electroscope as shown in Figure 1, and with the drum, *i*, screwed nearly all of the way up, the insulated system is charged by turning the button, *g*, *on* and *off*. The leaf is then brought exactly to the middle point (zero) of the eyepiece scale by turning the drum one way or the other, and the capacity scale on the drum is read—the reading is called C_1. The chamber unit is now removed, closed with the screw, *j*, carried to wherever it is to be used, and exposed to the rays for a definite length of time. At any convenient time thereafter, the screw is removed and the chamber unit is connected again to the electroscope, after which the drum is unscrewed until the leaf comes to zero, and the scale reading, C_2, is recorded. The dose is given by $(C_2 - C_1)$ KD in which K is a constant, the value of which is 6.52 e-units per cm. or 1.056×10^{13} electrons per gram of air per cm., and D is the ratio of the density of air at 0°C. and standard pressure to the density at the time of exposure. D may be tabulated for various temperatures and pressures for quick reference. The measurement is to be taken as satisfactory provided $C_2 - C_1$ lies between 5 cm. and 55 cm. The dosage rate is found, of course, by dividing the total dose by the time of exposure.

The value of K depends on the value of V, the potential required to raise the gold leaf to zero, on the value of v, which is the "equivalent volume" of the ionization chamber, and on other quantities which have to do with the units in which the dose is to be expressed. v was measured with the aid of a potentiometer and a voltmeter when the electroscope was first set up and adjusted; it came out to be 313.6 volts. So long as the instrument is not readjusted it will remain constant. It should be noted carefully that v is not necessarily the same as the voltage of the charging battery.

v was determined by direct comparison of the chamber with another chamber, the behavior of which is well known. For unfiltered rays produced at 30 kv. peak, it is equal to 0.160 c.c.; v varies to some extent with the hardness of the rays. If it be taken as constant and equal to 0.160 c.c., the resulting error may be as great as 2.5 per cent for certain rays produced between 30 and 100 kv.

Preliminary experiments made it clear that 25 volts are enough to saturate the chamber current for the most intense rays with which I have to deal. This corresponds to a maximum value of 64 cm. for $C_2 - C_1$. To provide a proper margin of safety, I set the limit at 55 cm. So long, then, as $C_2 - C_1$ does not exceed 55 cm. it may be assumed safely that the current has been saturated throughout the exposure. Now the scale is divided to 0.1 cm. and the accuracy of the scale and the sensitivity of the leaf justify reading to about 0.02 cm. If then $C_2 - C_1$ is as great as 5 cm., it can be measured with fair accuracy. The length of the exposure may lie, then, anywhere between a certain minimum value and 10 or 11 times that value. Very little experience is required to enable an operator to estimate the exposure with reasonable certainty that the first trial will be satisfactory.

If the electroscope is properly cleaned, and mounted at some little distance from the roentgen-ray plant, no account need be taken of its natural leak; this is true even though the chamber unit remain disconnected from the electroscope for a considerable period—a day or two perhaps. If the apparatus is of massive construction, and if the gold leaf is so adjusted that it cannot be injured by careless handling of the variable condenser (as it is in my instrument) there is no reason why it should ever get

out of order. If it is suspected that the chamber unit has been damaged by careless handling, its behavior can be checked in every detail without removing it from the electroscope. One particular advantage of this apparatus should not be overlooked; since the final adjustment of the leaf to zero is made by means of the variable condenser, the value of the battery voltage is of no great importance. If the batteries are set in paraffin, it should not be necessary to replace them for two or three years.

All things considered, the advantages of using apparatus of this kind for estimating dosage seem to me to be much more than sufficient to compensate for the single disadvantage—that the time of exposure must be estimated in advance. The apparatus is compact, fairly simple, and as nearly foolproof as anything of the kind can be made. It requires no attention over long periods. Once adjusted, its behavior may be checked up without the use of accessory apparatus of any kind. Aside from the matter of chamber design, which constitutes a problem quite independent of the nature of the rest of the apparatus, the measurements may be made as accurately as one wishes. Most important of all, the usefulness of the apparatus is not restricted to the immediate neighborhood of the electroscope.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

APPELRATH, H. A new technique for the roentgenography of the pulmonary apex. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 526–528.

The roentgenogram is taken with the patient in the recumbent position. In order to remove the clavicles from the pulmonary field the arms of the patient are crossed over the head with each hand grasping the elbow of the other. It is desirable to support the arms on a pillow so as to make the position more convenient for the patient. This crossing of the arms is necessary as otherwise the shoulder blades produce disturbing shadows in the apical fields. Respiratory rest is necessary. The rays are directed ventrodorsally toward the axis of the spinal column and inclined at an angle of 15 to 20° caudally. This angle is not necessary in all cases but always assures the elimination of the clavicular shadow from the lung picture.

The difference between this technique and the Albers-Schönberg technique is that in the latter the clavicular shadow is merely shifted from its place, whereas in the above described new technique this shadow is entirely eliminated from the picture.

BALENSWEIG, IRVIN. Femoral osteochondritis of adolescents and sequelae. *Surg., Gynec. & Obst.*, November, 1926, xliii, 604–614.

Brief reports are given of 18 cases of epiphyseal separation of the hip occurring in adolescents most of whom gave a history of injury. There were 20 instances of varying degrees of epiphyseal separation. Bilateral involvement was noted in only two of the cases. The sexes were about equally affected. The age at the time of first observation of the condition varied from ten to seventeen years, the average being 13.3 years. Nine of the 18 cases could be classified as overgrown and are regarded as belonging to the so-called endocrine type. Fifteen hips were subjected to mild injury, no one instance being severe enough of itself to cause a fracture in a normal child of the same age.

The duration of the condition prior to the institution of treatment varied from one hour to one and a half years, the average period being about six months. There was an end result shortening of from one-eighth to one inch, the average being about one-half inch. Those cases complicated by moderate or marked epiphyseal separation that are subjected to forcible manipulations result in varying degrees of arthritis.

In the cases with mild epiphyseal displacements the roentgenographic findings were (1) flattened appearance of the epiphysis due to backward rotation; (2) widening of the epiphyseal line; (3) haziness of the epiphyseal line; (4) occasional fragmentation in the region of the epiphyseal line (irregular islands of bone); (5) short and broad femoral neck due to outward rotation of the femur shaft; (6) juxta-epiphyseal bone absorption, occasional cavity formation; (7) downward displacement of the femoral head.

In the more advanced or untreated cases the roentgenogram showed (1) early stages resembling those above described; (2) varying degrees of displacement of the epiphysis; (3) late changes such as (*a*) premature ossification of the epiphyseal line, (*b*) occasional diminution of joint space, (*c*) occasional irregularity of head, (*d*) occasional flattening of the head resembling the late stage in some cases of Perthes' disease, (*e*) short and broad neck, (*f*) lessening of the angle between the neck and shaft of the femur due to incomplete reposition of the fragments, (*g*) nonunion (rare), (*h*) occasional erosion of the acetabulum, (*i*) capsular thickening.

In the group treated by the open method the roentgenogram showed (1) large irregular femoral head; (2) diminution of the joint space; (3) short and broad femoral neck and (4) diminution of the normal angle between the neck and shaft.

There is a distinct relationship between osteochondritis of adolescents and Perthes' disease. The author suggests the following possible sequence: In the first decade Perthes' disease; second decade, femoral osteochondritis complicated by varying degrees of slipping of the capital epiphysis; third decade and later, osteoarthritis.

BEER, EDWIN. Uric acid and uratic stones in the kidney. Uric acid showers and their diagnosis. *Surg., Gynec. & Obst.*, October, 1926, xliii, 436–442.

The failure to recognize uric acid stones and to interpret correctly the clinical picture associated with such stones or with showers of uric acid crystals is a serious diagnostic difficulty encountered by the surgeon, internist and roentgenologist. Reports are given of 6 cases of uric acid calculus in the kidney in which the diagnosis was made by a combination of all

the usual methods of examination in addition to the demonstration of a filling defect in the pyelogram of the diseased kidney, and usually confirmed by obtaining a positive scratch mark on a waxed whalebone bougie passed into the offending organ. These cases all came to operation and the diagnoses were confirmed. In these cases there were found rather large stones having a composition that failed to give shadows in the roentgenogram. It would seem that such stones are not at all infrequent in the upper urinary tract and they can be detected only by the most careful methods of study. Many patients with such stones seem to have suffered a long time and the recurring pains or colics are frequently associated with hematuria. The most valuable objective diagnostic criteria are a diminished output of indigocarmine, a positive scratch mark, and a defect in the pyelographic filling of the pelvis on the side of the stone.

Uric acid showers produce a clinical picture very similar to that produced by kidney stones, namely, typical colic, usually associated with red blood cells in the urine. In these patients there may be no evidence of uric acid in the voided specimen at the time of its passage, and microscopically only red blood cells or a few pus cells may be seen. On standing, however, such urine will precipitate smaller or larger crystals of uric acid which adhere to the sides of the test tube. This settling out of uric acid crystals probably occurs in the ureters under certain conditions and gives rise to the typical attack of renal colic characteristic of kidney or ureter stone. In such cases a most careful roentgenographic or cystoscopic study yields nothing diagnostic.

BOYDEN, EDWARD A. Sex differences in the contraction rate of the human gall bladder. *Proc. Soc. Exper. Biol. & Med.*, January, 1927, xxiv, 353–358.

It is generally recognized by practitioners that certain disturbances of the biliary tract are more prevalent among women, especially stout women, than among men. In the hope of finding some anatomical or physiological basis for clinical differentiation a cholecystographic study was made of the contraction of the gall-bladder in healthy young women following a standard meal of five egg yolks and half a pint of cream. In 7 of the 11 cases it was possible to follow the contraction of the gall-bladder until the shadow became very small. These 7 young women belonged to the same occupational group as the group of young men who were similarly studied by the author a short time ago. The changing volume in each series was then computed and contraction curves plotted.

A comparison of the two groups shows that the female gall-bladder instead of being more sluggish as might have been predicted, empties faster than the male. This striking contrast is due neither to a differing latent period nor to the fact that the gall-bladder of the male is usually larger and therefore has more bile to be expelled. If these findings are supported by a larger number of cases it may therefore be inferred that the initial digestion and absorption of such foods as egg yolk and cream take place more rapidly in young women than in young men.

Another significant feature in this comparison of the two sexes is the difference in size of the distended gall-bladders per unit weight. There is 1 c.c. of bladder bile for every $3\frac{1}{3}$ pounds of body weight in the young men but only 1 c.c. to every $4\frac{3}{4}$ pounds in the young women. It would thus appear that in respect to size the female gall-bladder is at a disadvantage especially if toward middle age the body greatly increases in weight as in fleshy women. This may be offset perhaps by the quicker emptying time so long as that function remains unimpaired.

No satisfactory explanation of these sex differences is at present available and no such differences have been observed by competent physiologists. Perhaps the explanation will be forthcoming when we know more about the effect on the gall-bladder of such conditions as acid stomach, chronic constipation and intestinal obstruction.

BRDICZKA, GEORG. Hour-glass stomach caused by strangulation in an inguinal hernia. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 529–530.

The case occurred in a man aged sixty-eight who had been suffering for nineteen years with a left sided inguinal hernia. A roentgenographic examination with the aid of a test meal disclosed the stomach divided into two sections, the lower one being inside the hernial ring. The channel connecting the two sections was of about the thickness of a finger, and its walls appeared smooth. The emptying of the lower gastric section was delayed. Peristaltic waves were superficial and were present in the lower portion of the stomach only. The duodenum began to fill in about ten minutes. After an hour the upper portion of the stomach was practically empty, while the lower was quite full and peristalsis rather slight. After six hours there was still a residue present in the lower segment of the stomach.

The hernial sac also contained a number of coils of the small intestine and a segment of the colon (apparently the transverse colon). A careful study of all the factors clearly indicated that carcinoma was probably not present and that this pseudo-hour-glass stomach was due entirely to the peculiar anatomical situation.

BRUNN, HAROLD, and PEARL, FELIX. Diffuse gastric polyposis—adenopapillomatosis gastrica. *Surg., Gynec., & Obst.*, November, 1926, xliii, 559–598.

Gastric polyposis may arise either congenitally or following inflammation. It is of interest to note that these tumors have been reproduced experimentally. The condition may appear either in the form of distinct polyps, adenomatous in nature, or as slightly elevated hypertrophic plaques resembling polyadenoma *en nappe*. The latter are regarded as being of telangiectatic origin.

The symptoms and physical signs are not characteristic. Achylia is the most significant finding; combined with fresh blood and abundant mucus it should suggest the diagnosis. The roentgenogram properly interpreted is the most valuable diagnostic sign. Gastroscopy and the examination of shreds from gastric washings are useful diagnostic factors.

In interpreting the roentgenogram, confusion and doubt may arise from the lack of knowledge of the various changes which may occur in the contour of the stomach as a result of these growths and from the inability to discriminate between chronic inflammatory hypertrophy and neoplasm in the roentgenogram. The roentgenological findings in polyposis are given by Dr. Howard Ruggles as follows: The characteristic roentgen-ray finding consists of irregular defects in the margin of the gastric shadow at the site of the tumors, which are usually upon the greater curvature. The masses projecting into the lumen produce an indentation in the barium shadow, with ragged edges, and there is commonly a tendency for a streak of barium to continue along the curvature of the stomach extending through the lesions for a variable distance, depending upon the angle at which they are viewed. When the tumor lies directly on a profile of the shadow and has a relatively broad base there will be little or no "under-cutting" visible. When the base of the tumor lies at a distance from the profile, this tendency of a thin line of barium to follow the gastric outline becomes more pronounced and finally when the tumor arises from the anterior or posterior walls the defect in the margin disappears entirely and the picture is that of a more or less rounded mass lying wholly within the gastric shadow.

The differentiation from carcinoma is based upon the fact that the defect in malignancy is usually annular, involving both curvatures, the gastric wall at the side is obliterated, and the defect increases in size fairly rapidly while the course of the benign lesions is much slower. Foreign bodies such as food, hair balls, masses of vegetable fibers and other non-opaque material may be a source of confusion on single examination, but repeated observations and changes in the position of the patient should differentiate them. There are borderline cases in which one cannot differentiate roentgenographically between hypertrophic rugae from chronic gastritis and polyposis. This is exemplified in one of the cases reported in which history, laboratory findings and roentgenogram were characteristic for gastric polyposis but the authors found to their surprise at operation that only a marked hypertrophic condition of the mucosa was present. This suggests that final diagnosis of gastric polyposis must be made by direct inspection at operation. Detailed reports are given of 5 proven cases and of 6 probable cases.

Diffuse gastric polyposis is seemingly a rare disease since only 84 cases have been found in the literature. It is probable that these figures do not represent the true incidence of the disease. Malignant degeneration occurred in 12 per cent of the 84 cases collected. The treatment of the condition is surgical. Roentgen therapy was employed in one of the cases reported by the authors and there was considerable improvement. This may, however, have been coincident with the spontaneous remission which is not unusual in this disease. Statistics on the prognosis are inadequate principally because most of the cases have been diagnosed post mortem. Death appears to have been rarely the direct result of the disease. The growths are essentially benign.

CALLAHAN, WILLIAM P., and SCHILTZ, FRANCES H. Aneurism of the renal artery. *Surg., Gynec. & Obst.*, December, 1926, xliii, 724–728.

A report is given of a case in which the roentgenogram provided the principal aid in diagnosis. This occurred in a woman aged forty-four who complained of abdominal pain and backache, chiefly on the left. Hematuria was constantly absent. There was no palpable tumor and no pulsation. None of the clinical symptoms of aneurysm could be detected clinically. During the acute attacks which the patient had, relief was obtained after the menstrual flow was well established. The roentgenogram showed a shadow approximately the size of a hazel nut in the upper region of the left kidney. The periphery was very dense while the

interior was quite diffuse. The right kidney appeared normal. This is the third case of aneurysm of the renal artery in which positive roentgen findings were noted. A pyelogram showed the pelves to be of normal position, size and shape. The oblong blunt shadow on the left lay anterior to the plane of the pelvic projection and encroached upon it. The shadow was not typical of stone yet it was suggestive and a tentative diagnosis of renal calculus was made.

At operation the kidney was exposed by an extraperitoneal approach and a hard round mass the size of a walnut was found intimately associated with the renal pelvis and loosely connected with the renal artery just distal to its bifurcation. There was no pulsation but in an effort to dissect the mass, a small incision was made and immediately a spurt of blood from the sac revealed its true nature. The aneurysm was of the sacculated variety and hemorrhage was controlled by clamping the sac at its communication with the artery. The sac was excised and the perforation in the artery was closed without sacrificing the artery or any part of the kidney. The pathological diagnosis was arteriosclerotic saccular aneurysm of the renal artery.

Corbett, Rupert S., and Peirce, Carleton B. A clinical type of cholelithiasis resembling renal disease. *Surg., Gynec. & Obst.*, October, 1926, xliii, 459–464.

It has been observed that pyelitis is not an uncommon association with gall-bladder disease; although it is not clear whether the pyelitis leads to cholecystitis or vice versa. The most common infective agent in the urinary tract is *B. coli* and it is also the most common organism obtained from bile in cases of acute cholecystitis. Both conditions are more common in women than in men, and a pyelitis more commonly affects the right kidney than the left.

In the 2 cases reported the renal symptoms predominated, yet the findings in the gall-bladder appeared to be more advanced than those in the urogenital tract. In addition to this the rapidity with which the urinary symptoms cleared up after operation was remarkable. These cases occurred in women aged fifty-two and thirty-seven years respectively, who presented a clinical picture suggestive of renal disease. In each case there was large gallstone formation, a moderate degree of pathological change in the wall of the gall-bladder and a very fair shadow of the viscus after the oral administration of tetraiodophenolphthalein.

In the first case pyelographic examination showed the right pelvis normal although the kidney was low in position. Opposite the tip of the transverse process of the fourth lumbar vertebra was a shadow suggesting a gallstone, lying in very close relation to the kidney pelvis. Cholecystography disclosed an elongated shadow opposite the transverse process of the third lumbar vertebra. It was faint and not indicative of a well-filled gall-bladder. In the middle of this shadow were seen several shadows resembling gallstones. Cholecystography was repeated and a well-defined shadow of the gall-bladder was obtained, in the center of which four facetted stones were clearly seen.

In the second case, the pyelogram showed an apparently normal pelvis on the right. Shadows of increased density were seen along the twelfth rib, definitely separated from the kidney. Cholecystography demonstrated shadows very suggestive of gallstones.

Since the gall-bladder shadow was so easily obtained it is concluded that in both cases the liver function was normal, the cystic duct was patent, and the concentrating power of the cystic mucosa was good. These conclusions make it difficult for the authors to reconcile themselves to the generally accepted view of the etiology of gallstones.

Eisendrath, Daniel N., and Koll, Irvin S. The pyelographic diagnosis of renal and pararenal neoplasms. *J. Am. M. Ass.*, Nov. 13, 1926, lxxxvii, 1640–1644.

Ureteropyelography is almost indispensable in the differential diagnosis of renal and pararenal neoplasms from those arising from intraperitoneal structures. The most typical roentgenographic alterations in contour, location, etc., may be grouped as follows: (1) spider, dragon, carnation-like and similar distortions; (2) filling defects; (3) displacements of the ureter either with or without accompanying changes in the pyelogram; (4) those in which the pyelogram or ureterogram or both do not differ in appearance from those seen in congenital conditions (atony or stricture), in inflammatory dilatation or in cases of nonmalignant obstruction of the ureter or kidney. In these a differential diagnosis is impossible from the ureteropyelogram alone. (5) Pyelograms in which the findings do not vary from the normal.

The deformities above mentioned are of unquestioned value in the diagnosis of renal neoplasm and polycystic disease. If one can exclude blood clots, fibrinous exudates, etc., in the renal pelvis the presence of a filling defect is quite typical of neoplasm. Deviation of the ureter is found in both pararenal and intrarenal neoplasms. In pararenal growths, there is no change in the contour of the pyelogram, but

the latter may reveal evidences of rotation or displacement of the kidney. In intrarenal neoplasms there are always pyelographic changes in addition to the ureteral displacement. Familiarity with the many variations in normal pyelograms especially of the "pseudospider" type is essential in order to avoid errors in pyelographic interpretation. Certain nonmalignant inflammatory conditions either of the fatty capsule or of the parenchyma of the kidney may give rise to pyelographic changes greatly resembling those of neoplasms.

GALDAU. A new case of chronic intussusception diagnosed roentgenologically. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 540–542.

The case occurred in a man aged thirty-six. The roentgen examination showed the stomach hypertonic, drawn to the right and upward placing it in a diagonal position. Peristalsis was deep and almost segmental, the bulbus was normally outlined and always filled, evacuation was very rapid. The various coils of the small intestine were well filled out, the barium tarrying there for a long time, and the coils showed no Kerkring's folds. The pyloric and ileocecal regions were sensitive to pain. In the ileocecal region there was a sausage shaped tumor with the long axis vertical. After five hours there was a slight residue in the stomach and duodenum, and the barium had travelled to the distal portion of the ileum. The latter was dilated and showed a large barium conglomeration in the right iliac fossa. After seven hours the stomach and duodenum were empty. The greatest portion of the barium was still in the ileum. The ascending portion of the cecum was not filled; in the hepatic flexure, which was ptotic and distended with air there was visible an irregular mass of barium. Barium was also visible in the transverse segment. After nine hours much barium was still present in the ileum, the ascending portion of the cecum was not visible and the transverse portion irregularly filled. The splenic flexure contained very much gas. The upper portion of the descending segment was filled with barium; below the splenic flexure it showed a horizontal surface. By compression upon the transverse colon it was possible to force the barium over a long stretch into the descending colon. The barium fell into the latter as if into an empty sac and assumed a horizontal position there. The diagnosis based upon these findings was chronic ileocecal intussusception, the invaginated portion extending down to the splenic flexure, apparently due to tuberculosis (active signs of which were noted in the lungs and from the clinical history). The operation confirmed the diagnosis.

In the above case the following signs already noted in the literature were present: Stierlin's sign (which is classic for ileocecal tuberculosis) with ptosis and dilatation of the hepatic flexure; stasis in the lowest portion of the ileum; hyperkinetic stomach drawn to the right. To this the author adds the following sign which has hitherto not been described: the possibility of working the barium directly over a long stretch of the intestine; in this case from the transverse colon by way of the ileum into the descending colon. This procedure requires considerable patience and time on the part of both the physician and the patient, and where circumstances permit this particular sign can be demonstrated.

HAMMER, GERHARD. Situs inversus of the aortic arch. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 517–523.

A right sided aortic arch occurs very frequently in conjunction with a congenital organic heart lesion and is justification for suspecting the existence of such lesion. It is, however, not permissible to assume the existence of such an organic lesion without confirmatory clinical symptoms and at no time does it indicate the nature of the lesion. A right sided aorta can occur without an accompanying organic heart lesion and may be found in clinically healthy and entirely efficient cardiac systems. The transposition of the aortic arch is in itself no symptom of major clinical importance and in itself gives rise to no symptoms. Symptoms of dysphagia may perhaps occur when the descending aorta or a subclavian artery with an abnormal origin crosses the esophagus so as to dislocate and compress it.

A description is given of a case occurring in a man aged thirty-seven. This anomaly was discovered roentgenographically incidental to a chest examination. The central shadow was unusual. The first arch springing from the left side of the heart was missing, but the pulmonary auricular arch was quite distinct. Otherwise the heart shadow showed nothing unusual in shape or size. To the right was seen a short arch which extended downward to the left as a uniform broad band. This was recognized as the aorta. In the horizontal orthodiagram one could see distinctly how the ascending aorta travelled upward from its point of origin in a curve convex toward the left, forming the arch or aortic button to the right of the trachea above the right main bronchus. Roentgenograms taken in the sagittal and oblique planes confirmed the diagnosis. It is observed that in

this case the situs inversus is not an exact mirror image of the normal condition for in this case the diameter of the descending aorta did not quite approach that of the ascending such as is normally the case when viewed in the first oblique diameter.

Harrison, Guy R. Calculi of the salivary glands and ducts. *Surg., Gynec. & Obst.*, October, 1926, xliii, 434I–35.

Calculi of the salivary glands and ducts, though uncommon, are not rare, and are always of clinical importance. The condition occurs at all ages and may affect any of the glands, the submaxillary being most often involved. The stones are usually single but may be multiple.

The symptoms are local and due to obstruction to salivary outflow. When secondary infection occurs there is an accentuation of local symptoms together with certain constitutional manifestations which at times may become quite serious. The treatment is surgical; and gratifying results follow invariably after timely and proper removal.

A presumptive diagnosis is fairly easily reached but requires certain important differentiations. Specific localization of the calculus is often very difficult. At times this is necessary and is dependent largely upon a carefully developed roentgenographic technique. In a certain percentage of cases salivary stones cannot be demonstrated roentgenographically. Positive information can be obtained by this means in only about 75 to 80 per cent of the cases and then only by careful and repeated examinations. Failure to locate the stones roentgenographically is due to their unusually small size. Moreover, the anatomy of the parts involved is such that it is with difficulty that shadows of superimposed structures can be eliminated. The amount of tissue which the rays have to penetrate to reach the roentgenographic plate is so great that if sufficient penetration is given to traverse the mass of tissue the shadow of the stone is often obliteraed.

A series of 27 cases is reported on. One occurred in the sublingual gland and one in the sublingual duct and both of these were diagnosed roentgenographically. There were 5 cases of stone in the submaxillary gland and 10 in the submaxillary duct; of these 13 were diagnosed roentgenographically. Stone in the parotid gland was found in 3 cases and in the parotid duct in 7 cases; of these 10 cases, 8 were diagnosed roentgenographically.

Herger, Charles C., and Schreiner, Bernard F. Strictured ureters, hydronephrosis and pyonephrosis occurring in cancer of the cervix uteri. *Surg., Gynec. & Obst.*, December, 1926, xliii, 740–743.

An investigation was made of the bladders, ureters and kidneys in patients suffering from cancer of the cervix uteri. In all, there were 32 autopsies performed and 21 showed gross pathological changes in the urinary apparatus consisting of strictured ureters, hydronephrosis, pyonephrosis, caseous kidney and infiltration of the bladder. In addition, a clinical study was made of 50 cases of far advanced cancer of the cervix to determine the frequency with which the above lesions occurred. Fourteen of these cases on cystoscopic examination showed definite ulceration and infiltration of the bladder mucosa in the region of the trigone. The remaining 36 cases showed an elevation of the area just beyond the trigone which was covered either with normal mucous membrane or was edematous in spots. The phthalein renal function test was performed on 22 cases and it was found to be 30 per cent or less in fifteen minutes in 8 of these cases and between 30 and 62 per cent in 14 cases.

Pyelograms were taken, the effort being made to include the whole kidney region, ureters and bladder to show strictures in the broad ligament area or at the brim of the pelvis as well as the dilatation of the ureters. Five were without any obstructive lesion and 9 cases showed some evidence of ureteral or pelvic dilatation. In 6 cases, it was impossible to pass a ureteral catheter beyond the strictured area. These obstructions occurred most frequently in the lower 2 inches of the ureter. Twenty-four of the 50 cases showed hydronephrosis or dilatation of the ureters due to stricture of varying degrees in one or the other ureter, or both. This was divided as follows: left ureter 6, right ureter 11, both ureters 7.

It is concluded that these strictures are the result of pressure on the ureter from invasion of the broad ligament or bladder wall. In advanced carcinoma of the cervix uteri about half the cases showed obstruction of the ureter, with hydronephrosis and pyonephrosis. Even after complete eradication of the disease by radiation therapy, one patient died from kidney insufficiency in which autopsy showed cervix, uterus and broad ligament areas free from cancer.

Hickey, Preston M., and Simpson, Walter M. Primary chondroma of the lung. *Acta radiol.*, December 15, 1926, v, 475–500.

A report is given of the roentgenological and pathological aspects of 40 cases of primary chondroma of the lung (including 2 new cases). The disease undoubtedly occurs with greater frequency than a review of the literature would indicate, and progress in roentgenology has stimulated interest in these tumors.

No case has ever been properly interpreted roentgenographically. Macroscopically the tumors usually appear to be made up of multiple islands of cartilage separated by vascular connective tissue and adipose tissue. Calcification or ossification of the cartilage occurs in most instances. The tumors are almost invariably surrounded by normal lung tissue. Two gross characteristics of these tumors which possess differential diagnostic importance are, the invariably nodular, lobulated periphery and the patchy, haphazard calcification or ossification.

Microscopically in addition to the calcified or ossified cartilage, connective tissue and fat tissue, one usually finds complex glandular structures in the septa between the cartilage units, lined by cuboidal or columnar epithelium. Smooth muscle has been described in a few cases.

The majority of the tumors were located just beneath the pleura and in only 6 of the 40 cases was there any close association with the bronchi. These complex tumors probably have their origin in displaced bronchial anlagen, since all of the histological elements found in them are normal components of the bronchi. The few cases which have been studied roentgenologically have been diagnosed as echinococcus cyst. The lobular, nodular periphery and haphazard calcification, or ossification of the pulmonary chondromas together with an absence of clinical manifestations of taenia echinococcus infestation should serve to distinguish these tumors. The practical importance of such differentiation is apparent when one considers the great difference in the treatment of the two diseases.

Jung, Paul, and Schirmer, A. On the combination of the pneumoperitoneal roentgenogram of the organs in the small pelvis of the female with hysterosalpinography. *Acta radiol.*, Oct. 15, 1926, v, 395–407.

The ordinary pneumoperitoneal roentgenograms of the small pelvis in the female have been encumbered by difficulties in interpretation particularly in respect to the relationship to neighboring organs. By a combination with salpingo-hysterography, i.e., the contrast filling of the uterus and tubes with lipiodol, the interpretation of the roentgenogram is greatly facilitated in diseases of the adnexa, tubal pregnancy, the differentiation of adhesions and diseases of adjacent organs, etc.

Salpingo-hysterography alone, for testing the patency of the tubes, has the great advantage over simple tubal insufflation of being an optical method less liable to subjective misinterpretations than the merely acoustic one. In connection with pneumoperitoneum it enables one to learn something of the nature and location of the obstruction and in addition gives better information regarding the shape and degree of development of the uterus. In the diagnosis of intrauterine changes (tumors, polyps, irregularities in the mucosa), salpingohysterography should be quite fully able to replace the complicated and not harmless method of dilatation and palpation of the uterus cavity. It is in this field that the combined methods of pneumoperitoneal roentgenography and salpingo-hysterography will in the future find their main field of usefulness in gynecological diagnosis.

The authors have employed the procedure in about 150 cases and have observed no after-effects. A series of 19 illustrative roentgenograms is reproduced.

Junghagen, Sven. Roentgenological skeletal changes in Gaucher's disease. *Acta radiol.*, December 15, 1926, v, 506–516.

A report is given of a case of Gaucher's disease which showed extensive roentgenological changes in the skeleton. These changes were characterized by (1) a pronounced general calcium deficiency (atrophy) in the skeleton; (2) the spongiosa markings showed coarse porous trabeculations; (3) destruction of the spongiosa which occurred either in small sharply circumscribed areas in which the bones possessed a worm-eaten appearance or in large areas leading to more extensive defects. (4) The cartilage and periosteum remained for the most part unchanged roentgenologically.

The case reported occurred in a little girl aged three. The disease attacked the hip joints producing a coxa valga, and also the thoracic spine producing a kyphosis. The skin on the dorsal side of the forearms and hands showed a blackish-brown pigmentation, while the volar surfaces of the hands and the fingers and the upper arms were distinctly lighter colored. There was no sharp demarcation of the pigmented area in the cheeks.

Møller, Eggert, and Ottosen, David. Cholecystography. *Acta radiol.*, Aug. 30, 1926, v, 313–332.

A detailed description is given of Graham and Cole's method of cholescystography, of the development of the method up to the present and of the most important results it has yielded. The details of the technique for intravenous infusion of the contrast agent and for roentgenography as practiced at the University Clinic and Rigshospital, Copenhagen, Denmark, are given.

The method has been used in 36 cases in whom 42 examinations were made altogether. Local reaction did not occur in any case. There was a mild or moderate general reaction in 6 cases. Twenty-two cases did not have gall-bladder disease and were regarded as normal in that respect. In 2 of these cases cholecystography gave no shadow of the gall-bladder. In one of the latter, adhesions around an ulcer may possibly have prevented the gall-bladder from filling. In the second case no explanation was found for the absence of the gall-bladder shadow. Attempts were made to determine the size of the gall-bladder shadow in these cases. The length of the shadow was found to vary between 3.5 and 9.0 cm. and the width from 1.5 to 4.0 cm. The latter dimension is the more accurate of the two, because it is often very difficult to decide exactly at which point the gall-bladder shadow ends in the upward direction.

There were 14 cases with symptoms indicating gall-bladder disease; 3 of these cases had shown gallstones on simple roentgenological examination; one case failing to show a gall-bladder shadow may have been due to adhesions from a duodenal ulcer; of the remaining 10 cases a normal gall-bladder shadow was obtained in 7, although they all presented more or less marked symptoms of chronic disease of the bile ducts.

Oakman, Carl S. Radiographic diagnosis of gall-bladder disease. *Radiology*, September, 1927, vii, 201–210.

In order to determine the relative importance of roentgen-ray criteria of gall-bladder disease an analysis was made of the roentgenoscopic reports and the films of 70 cases that had subsequently come to operation for gall-bladder disease at the University Hospital, Ann Arbor, Mich. As a result of the analysis of the indirect signs in these 70 cases the following conclusions are drawn. There is no indirect sign that occurs in all cases of gall-bladder disease. There is no one indirect sign that is surely pathognomonic of all gall-bladder disease.

The major important indirect signs are the following: (1) hepatofixation of the antrum; (2) displacement of the bulb to the left or downward to the right; (3) definite pressure deformity of the antrum or bulb; (4) distortion of the bulb by adhesions or spasm; (5) fixation of the colon close to the gall-bladder; (6) tenderness located in the gall-bladder area during roentgenoscopic examination; (7) displacement of the second part of the duodenum to the right. The greater the number of signs present in a case, the greater the likelihood of gall-bladder disease. In the presence of certain of these signs the probability of gall-bladder disease increases in proportion to the ability to rule out intrinsic disease of stomach, duodenum, pancreas and appendix. The estimation of the value of these signs is enhanced by conference with the clinician in each case.

Direct roentgen-ray signs were sought in 48 of the cases, of which 10 showed a definite or suggestive shadow of the gall-bladder. A review of the films revealed gallstones in 9 cases out of 39 where they were later confirmed operatively.

If the search for both direct and indirect signs has ended fruitlessly, the diagnosis of gall-bladder disease cannot be excluded and this is likely to occur in at least one case out of five. It is quite apparent that the barium meal will present many indirect signs of gall-bladder pathology no one of which is pathognomonic, and it is only by the experienced roentgenologist that these signs can be safely interpreted. In the routine barium meal examination the roentgenologist will continue to note signs caused by pathology elsewhere than in the gall-bladder without adequately explaining their significance, unless the data gathered from the Graham test are correlated with those gathered from the barium meal. The pathologic gall-bladder causes many functional abnormalities in the region around the gastric outlet; the Graham test now permits us to state quite definitely in a given case whether or not these abnormalities are associated with a pathologic gall-bladder. In the course of time the accumulated knowledge thus gained ought to make the barium meal of greater diagnostic value than ever.

Orndoff, B. H. Roentgen-ray studies of the appendix, cecum and ascending colon. *J. Am. M. Ass.*, Oct. 16, 1926, lxxxvii, 1294–1297.

In addition to the usual observations in the erect and reclining postures, emphasis is placed on the necessity of making observations while the patient is rotated. The appendix is located in the iliac fossa more frequently than in all other locations combined and the cecum is usually located in conjunction with the appendix. The ascending colon and hepatic flexure usually occupy a position between the iliac fossa and the right hypochondrium posteriorly. The location of these organs has very little importance except when it may compromise their function.

By fixation is meant the absence of that degree of mobility which has been found normal under proper technique of examination. An appendix fixed at any portion and causing angulation in certain postures may be regarded as pathologic. Fixation at any point of the intestine with angulation is pathologic, and the

degree of disturbance in function usually determines its clinical importance.

Tenderness of the appendix can probably be elicited only in conjunction with roentgen-ray observation, and in rare cases it cannot be determined. A tender appendix carries far more clinical value than tenderness at McBurney's point. Tenderness at definite points along the colon can usually be determined accurately, and its importance can be appreciated in connection with the other clinical aspects of the case.

There is no abnormal position without fixation. Experience with the roentgenoscope is the only means whereby the roentgenologist may develop a clear conception of the normal capacity to function. Masses of opaque substance retained in the region of the hepatic flexure have less clinical importance than retention in the appendix and cecum. Opaque masses are not retained at the point of intrinsic lesions. By skillful palpation tenderness between masses of retained barium may be elicited and this is of clinical importance.

In the young, the lumen of the appendix is frequently found to retain a degree of the fetal type and to appear funnel shaped at the proximal end. In adults the appendix is nearly always smaller at the neck and the folds of the mucosa aid in producing a valve effect. Normally the lumen maintains almost the same size throughout its entire length. There is a tendency of the lumen to increase in size with increasing age. Definite obliteration of the lumen is a pathologic change. An appendix showing fixation at the distal end and whose lumen narrows to a point when barium is put under pressure by palpation is undergoing obliterative change and is frequently symptom producing. An appendix with a dilated distal end and a narrow proximal lumen is pathologic, frequently shows an appendolith or retention and is frequently potentially surgical. It has been suggested that obliteration of the appendix after the patient is thirty may be a purely normal physiologic phenomenon. General obliteration or obliteration of the distal end is regarded as of little consequence so long as the cecal orifice remains funnel shaped and thoroughly patulent.

Central obliteration of the appendix has frequently been observed in cases in which the capacity to fill and empty was deranged and in which the patients later developed a condition demanding surgical removal. It is the type that most frequently becomes inflammatory. Partial central constriction from angulation, fixation or other conditions of a pathologic-anatomic character constitutes a fairly large percentage of the pathologic appendices which of themselves do not warrant radical intervention; but when considered in the causation of the patient's general condition their removal constitutes one of the most successful procedures.

PANNER, H. J. Some observations on capsular chondromatosis and its roentgenological characteristics. *Acta radiol.*, Aug. 30, 1926, v, 295–303.

Capsular chondromatosis has not been reported very frequently although it probably occurs oftener than is suspected. The detection of this condition will usually come from the roentgen examination, hence the importance of knowing the roentgenological characteristics.

The symptoms consist of a greater or less diminution in the movements of the involved joint and in the swelling of the surrounding tissues. Within this swelling one can easily detect the presence of the different elements composing it, frequently in the form of movable bodies.

In most cases, the roentgenological findings together with the clinical symptoms will easily differentiate capsular chondromatosis from atrophic arthritis and osteosarcoma. The roentgenogram shows the presence of opacities corresponding to cartilaginous tumors, more or less calcified or ossified, found in all parts of the capsule as well as in the neighboring serous bursae. There are also present clearly defined defective areas in the bone, the results of erosion produced by the pressure of the penetrating tumor. One notes particularly the absence of any deforming arthritis; only in the angle of the joint does one find fairly often small osteophytes which should be regarded as secondary formations due to the presence of too many foreign bodies in the joint. Two illustrative cases are cited.

PHEMISTER, D. B., and GORDON, JOHN E. The etiology of solitary bone cyst. *J. Am. M. Ass.*, Oct. 30, 1926, lxxxvii, 1429–1433.

The solitary bone cyst is essentially a disease of the growing period and rarely begins after adult life is reached. It has become extensively recognized and investigated only since the introduction of roentgen rays. Four main theories have been advanced to explain it. These are that it is (1) a degenerated tumor; (2) a localized malacia or dystrophy; (3) the result of hematoma in the bone marrow, and (4) an infection.

The tumor theory has been abandoned. Against the theory that it is a localized malacia are the facts that there are no generalized changes in the skeleton, no increased calcium metabolism and no parathyroid en-

largement. The hematoma theory offers a very inadequate explanation of solitary bone cyst. The age incidence of the disease closely parallels that of staphylococcus osteomyelitis, about 95 per cent of the cases of which begin during the period of growth. Cyst is, however, less common in the very young than is osteomyelitis. Pathologic evidence in favor of the infectious theory is more abundant. The disease usually begins centrally in the end of the shaft. At the stage when pathologic examinations are made there are found more or less extensive destruction and complete removal of marrow, cancellous bone and inner portions of the cortex with the creation of a cavity filled with a serous or serohemorrhagic fluid and partly lined by a layer of grayish red to brown soft tissue. Sequestrums have not been found, which means that the destruction probably proceeds slowly by caries without extensive and rapid necrosis of bone. A singular feature is the necrosis and disintegration of cells bordering on the cavity with extravasation of blood into the necrotic tissue.

The pathologic picture during the active stage is that of a localized progressive inflammatory process, producing marked central bone absorption by tissue which in turn breaks down, but without appreciable new bone formation from the overlying periosteum. The disease is a self limited one and usually heals either as the result of one or more fractures or spontaneously after a protracted course.

Two cases are described in which study was made of the gross pathologic characteristics and in which cultures yielded microorganisms and the microscopic examination showed typical signs of inflammation. The evidence from these two cases is too incomplete to be conclusive but it is strongly suggestive that *Streptococcus viridans* was the cause of the disease in each case.

RHINEHART, B. A. Spontaneous pneumothorax: Report of a case apparently following whooping-cough. *Radiology*, September, 1926, vii, 253–254.

The case occurred in a woman aged thirty-four who had had the usual diseases of childhood except pertussis. During a local epidemic of whooping cough, she had a severe attack of this disease which required hospitalization for a month. During this time she had many severe attacks of coughing, vomiting and choking. Since then there has been a slight dyspnea on exertion, and during the menstrual periods a dull aching pain in the lower part of the right side of the thorax.

Roentgenoscopic examination showed the right lung to be partially collapsed with a small amount of fluid in the right pleural cavity. The upper level of the fluid was an inch below the highest part of the right arch of the diaphragm. The excursions of the arches of the diaphragms were equal. The heart and aorta appeared normal.

Stereoscopic roentgenograms also showed the zone of air around the right lung; there were no evidences of adhesions or thickening of any part of the right pleural membrane. The lung was clear of all evidences of tuberculosis or other inflammatory disease. Trunk markings immediately adjacent to the hilus were slightly accentuated probably due to congestion. The left lung was clear.

It is believed that the rupture of the lung was due to the severe strain during the paroxysms of whooping cough and that a preexisting pleural bleb was the site of the rupture.

SCHÜLLER, ARTHUR. The roentgen-ray findings in a series of cases of headache. *Radiology*, September, 1926, vii, 190–200.

Certain types of severe and obstinate headache yield negative roentgenograms. This is true of various forms of nervous cephalalgia, and headache associated with vasomotor disturbances due to anemia, venous stasis in heart and lung diseases and congestions. This group also includes the toxic headaches of gastrointestinal, uremic, diabetic and infectious origin.

The various types of headache in which positive roentgen-ray findings are frequently found may be classified in the following groups: (1) syphilis and various other inflammations, also neoplasms of the skull; (2) traumata of the head; (3) organic diseases of the brain and meninges; (4) diseases of the cerebral arteries, and (5) diseases of the accessory sinuses of the cranium.

Syphilis often gives rise to obstinate headaches. One of the most frequent pictures is that of circumscribed osteoperiostitis of the cranial dome. In addition to osteoporotic foci there may be observed transparencies produced by gummata, roundish or kidney-shaped, vaguely outlined defects and also reticular transparencies which correspond to the ramifications of the diploic vein channels of the cranial dome. All these changes including the hyperosteogenic type of cranial syphilis may be found in the roentgenogram of the skull of the same individual. Frequently however, a certain unevenness is revealed in profile roentgenograms of the heads of normal persons which closely resembles the periosteal syphilitic deposits, so that often a false diagnosis of syphilis is reached. However, since

the two sides present a symmetrical appearance the differentiation from syphilitic periostitis does not usually offer any difficulty. In comparison with syphilitic osteitis the other inflammations of the cranial bones occur but seldom. These are tuberculous osteitis, pseudomyelitis and mastoiditis. Another group comprises the cranial changes in osteitis deformans (Paget), osteitis fibrosa (Recklinghausen) and tumors of the cranial bones.

In cases of headache arising from cranial injuries, the roentgen findings are of manifold nature. The author has observed in cases diagnosed as "traumatic neurosis" extensive fissures in the roentgenogram months or years after the trauma. Occasionally foreign bodies in the interior of the skull may be discovered in patients complaining of headache of unknown origin.

Another group of affections in which the roentgenogram furnishes valuable diagnostic findings is the group of intracranial tumors and other intracranial processes that increase brain pressure. Hydrocephalus associated with tumors of the posterior cranial fossa or as a sequel of meningitis adhesions at the base of the brain or at its convexity shows the following roentgenographic picture. The cranium is spherical in shape, enlarged, the walls are thin, the impressiones digitatae are deepened, the sutures are widened and the sella turcica, owing to the pressure of the third ventricle is hollowed out. In unilateral hydrocephalus and tumors of the cerebrum, the roentgenogram shows the side of the cranium containing the hydrocephalus or the tumor as enlarged and having thin walls and deepened impressiones digitatae. Frequently, however, the portion of the cranium containing the tumor is normal or there may be local thickening only, whereas the opposite side owing to hydrocephalic widening of the lateral ventricle appears thinner than normal.

Tumors of the pituitary body, auditory nerve, aneurysms of the basal arteries and meningiomas cause local superficial ulcerations, less frequently localized hyperostosis of the portion of the base of the cranium to which they are attached. Another frequent type is turricephalus, characterized by the peculiar shape of the skull, the predominance of the vertical diameter, the abrupt rise of the forehead, the thinness of the cranial wall, the deformation of the base of the cranium and the absense of enlargement of the sella turcica.

In true idiopathic migraine there is found, not infrequently, deepening of the impressiones digitatae, a sign which points to a disproportion between the size of the cranium and the brain, evidently caused by the abnormal size of the brain. Also in symptomatic migraine often occurring in persons with mild tuberculosis, the roentgenogram shows signs of a slight increase of brain pressure.

The author stresses the diagnostic importance of the accentuated impressiones digitatae. These are always to be regarded as a symptom of the disproportion between the brain and the capacity of the cranium, even though clinical symptoms do not exist at the time of the examination or did not exist previously. Symptoms of disproportion do not usually appear until brought about by such causes as acute fevers, mental or physical over-exertion or cranial injuries. Under these circumstances sudden death frequently occurs, the cause of which at necropsy can be assigned to no other anatomical change except these accentuated impressiones digitatae.

Often the roentgenogram shows deepened pacchionian depressions at the spot designated by the patient as the seat of the obstinate localized headache. Sometimes the pain is stated to be more severe along a definite line and the roentgenogram then shows, sometimes, that, corresponding to the line mentioned there is a widened suture or broad venous canal which penetrates the bone deeply. It should be recalled that headache is one of the most constant symptoms of arteriosclerosis of the brain arteries. It is not such a rare thing to be able to demonstrate through roentgenograms that the larger basal arteries are calcified in elderly persons who present clinical manifestations of cerebral arteriosclerosis.

The last group of frequent positive roentgen findings in headache is represented by the affections of the air spaces. Acute inflammations of the accessory sinuses are revealed in the roentgenogram by shadows in the normally light area of the affected sinus. In addition to acute and chronic inflammations in the sinuses, one should also keep in mind the various tumors in the accessory sinuses and the bony parts. The above is believed by the author to be the first complete enumeration of the affections causing headache in so far as they come within the scope of roentgenologic examination.

SINGER, J. J. A simple method of introducing iodized oil into the lungs. *J. Am. M. Ass.*, Oct. 16, 1926, lxxxvii, 1298–1299.

The patient's tongue is pulled out as far as possible and the iodized oil is applied above the root of the tongue and the soft palate. A straight cannula is connected to a 20 c.c. syringe, and the tip of the cannula is positioned without touching either the tongue or soft palate. The patient is cautioned not to swallow during the introduction of the oil which is done

very slowly. This method has been used in 26 cases and in only 2 instances was there failure to obtain a roentgen plate of diagnostic value. This method is of advantage in that no special instruments or anesthesia are required. If this simple method of aspiration proves unsuccessful then a more complicated procedure may be resorted to if desired.

SLOMANN, H. C. On the demonstration and analysis of calcaneo-navicular coalition by roentgen examination. *Acta radiol.*, Aug. 30, 1926, v, 304–312.

The author emphasizes the necessity of appropriate roentgenographic examination for a safe judgment as to the existence of calcaneo-navicular coalition and the details of its structure. The commonly used straight mediolateral projection is inadequate for a true interpretation. A better position is one in which the planta is inclined about 45° to the photographic plate. This is demonstrated by the author in ordinary photograms of the skeleton of the foot as well as roentgenograms. These pictures show that there is no contact between this "apophysis" and the os naviculare such as is claimed to be present by Nové-Josserand.

STAPFF, RICHARD. A family with hereditary syndactyly and polydactyly (hyperphalangia pollicis). *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 531–538.

Reports are given of 6 cases of webbed fingers; and there is presented a family tree covering six generations in which the inheritance of this deformity has been traced.

STEIN, IRVING F., and ARENS, ROBERT A. Intra-uterine fetal death. *Radiology*, September, 1926, vii, 227–233.

The history of cessation of fetal motion, absence of heart tones, a peculiar stillness on auscultation over the uterus, and a low basal metabolic rate are significant clinical data in establishing the diagnosis of intra-uterine fetal death.

The authors have observed overlapping of cranial bones and asymmetry of the head in the live fetus to the same degree as in the dead. Therefore these signs are not pathognomonic of fetal death. Collapse of the vertebral column in the dead fetus cannot be distinguished in the roentgenograms from apparent or illusory acute angulations of the spine in the live fetus.

The fetus may be dead certainly as long as four days and fail to show overlapping of cranial bones or asymmetry of the head. It is concluded therefore that the roentgenographic diagnosis of intra-uterine fetal death cannot usually be made independent of other clinical data. This study of a group of 21 cases comprising 11 cases of intra-uterine fetal death and 10 in which a live fetus was delivered but gave apparent evidence on the roentgenograms of fetal death seems to indicate that the conclusions of Spalding and of Horner were not based on sufficient observations.

STEIN, IRVING F., and ARENS, ROBERT A. Iodized oil and pneumoperitoneum combined in gynecologic diagnosis: preliminary report. *J. Am. M. Ass.*, Oct. 16, 1926, lxxxvii, 1299.

The woman, aged twenty-five, had been married three years and was sterile. Examination revealed a mass in the right adnexa, almost fist sized, which was adherent and tender. The cervical examination was negative. The fallopian tubes were found patent by the passage of carbon dioxide at a pressure of 80 mm. After 1 liter of gas was thus introduced into the peritoneal cavity, 2 c.c. of lipiodol was injected into the uterus through the same cannula. The patient was then placed in the partial knee-chest posture and stereoroentgenograms were made. It was found that both tubes admitted lipiodol through their entire length and there was no tubal pathologic change. The right ovary was cystic, about 7 cm. in diameter and adherent to the bowel. These adhesions were clearly visible.

STÖFFEL, HANS. Loose fibrin body in pneumothorax cavity. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 548–551.

A description is given of a case presenting a movable fibrin body, big as a goose egg, in the pleural space after the resorption of exudate in a seropneumothorax. Roentgenographically this structure was found to change its position in the thoracic space depending upon the position of the patient. An adhesion thread formed between the retracted lung and the diaphragm was probably torn loose during an artificial pneumothorax and concentric deposition of fibrin over this particle resulted in the free fibrin body reported. There was no evidence of any hemorrhage.

TEDSTROM, M. K., BOND, R. C., OLMSTEAD, W. H., and MOORE, SHERWOOD. Cholecystography in diabetes mellitus. *J. Am. M. Ass.*, Nov. 13, 1926, lxxxvii, 1603–1605.

A cholecystographic study of gall-bladders in diabetic patients was undertaken with the idea that the results would prove more reliable as regards to incidence of cholecystitis in diabetes than data based on purely clinical or surgical observation. During the past year all

diabetic patients under observation in the Barnes Hospital, St. Louis, Mo., were examined cholecystographically with sodium tetraiodophenolphthalein given intravenously. The criteria governing the interpretation of the roentgenograms were those published by Graham and Cole.

Seventy patients were examined and 27 (38 per cent) showed abnormal cholecystograms. Of diabetic patients past the age of forty, 44 per cent showed abnormal cholecystograms. These abnormalities were found to appear a decade or more earlier in women than in men. There were 29 males in the series and 7 or 24 per cent showed abnormal cholecystograms (5 of these were past the age of forty). Females were represented by 41 cases of whom 20 (49 per cent) showed abnormal cholecystograms (17 of the latter were past the age of forty). The significance of these figures for the incidence of abnormal gall-bladders in diabetes mellitus cannot be properly interpreted until there are available data regarding the incidence of abnormal gall-bladders in the average population.

There are several serious objections to the assumption that the pancreatitis accompanying cholecystitis is of etiologic importance in diabetes mellitus. All observers agree that diabetes is slightly more frequent in the male than in the female, and yet we find 2 cases of cholecystitis in women to every one in men. In spite of these and other objections there remains some evidence that bile duct disease may be of etiologic importance in diabetes. There have been undoubted cases of diabetes mellitus which have been cured following surgical intervention for bile duct disease. Without a doubt cholecystitis occasionally precipitates a mild degree of diabetes. One would have to conclude, however, that in diabetes cholecystitis is not of prime importance and is not to be placed in the same category as obesity, heredity, or arteriosclerosis.

WHITLOCK, S. B. Roentgenological study of the large intestine. *Radiology*, September, 1926, vii, 218–226.

A general discussion is given of the roentgenological aspects of the normal and abnormal large intestine. Brief comments are made on variations in shape and position, due to faulty formation and on arrested migration; tumors; diverticulosis; infections and inflammatory processes; chronic stasis with accompanying phenomena and miscellaneous congenital deformities.

The above observations are based on more than 300 cases studied at the Sarah Leigh Hospital and Clinic, Norfolk, Virginia.

ROENTGEN AND RADIUM THERAPY

BOWING, HARRY H. Menorrhagia and metrorrhagia due to certain benign diseases of the uterus, and their treatment by irradiation. *Radiology*, September, 1926, vii, 234–241.

When radium is available and can be applied directly to the uterine walls by way of the uterine canal, it is the method of choice. It should be supplemented with roentgen-ray treatment when the fundus is larger than a five or six months' pregnancy. When radium is not available, roentgen rays used alone are effective and as a rule must be repeatedly applied for some months. A thorough clinical examination and operative treatment where indicated are essential. The mental state of the patient should not be ignored.

The results of radium treatment at the Mayo Clinic have been generally satisfactory, because the cases were carefully selected and therapy was judiciously applied. When small and moderate doses of radium are used, it may be necessary to repeat them from time to time with an interval of several months elapsing between treatments. Provided the risk is not great, an operation is better than repeated applications of radium.

The result may occur immediately or after an interval of six or eight weeks. In some a gradual lessening of the quantity of the flow is noted. A few patients report an excessive flow at the period following the application of radium. When large fibromyomas are present, many months are required for their reduction.

The dose of radium radiation in these cases was small, moderate or large, depending on the condition. The small dose consisted of 200 to 300 mg-hr.; moderate 300 to 600 mg-hr.; and the large dose (the menopause dose) varied from 700 to 1200 mg-hr. The supplementary roentgen treatment had the following dose factors: 200 kv., 5 ma., 0.75 mm. Cu plus 2.0 mm. Al, 50 cm. distance, two 20 × 20 cm. fields, one on the anterior abdomen and one posterior, one hour exposure for each field. Fibromyomas require only one treatment when the uterus is of the size of a five or six months' pregnancy; but if the size should be greater the treatment may be repeated. The author questions the value of further treatment if amenorrhea supervenes.

BRUGMANN, W. Lymphogranulomatosis and roentgen treatment. *Strahlentherapie*, 1926, xxii, 280–288.

The results obtained in the Leipzig Medical Clinic indicate that roentgen treatment in granulomatosis prolongs life and cannot be

matched by any other known form of therapy. Roentgen therapy is limited on the one hand by cachexia and exhaustion of the patient, and on the other hand, by the occurrence of recidives which no longer respond to the radiation.

The method of irradiation has remained essentially the same except for alterations in the apparatus. The very small doses recommended by Chaoul were not employed but the radiation series was always very much prolonged, usually requiring two to three months for completion. By this method of treatment a new field receives half the skin erythema dose every second or third day. After all fields have received this dose, a second similar dose is administered in the same order of rotation. The portal is varied according to the localization (10 × 10 cm., 10 × 15 cm., 15 × 15 cm.). In R units each field is given two doses of 200 R in any single series. New series, shortened where necessary, may follow but not before a pause of a month. In addition to roentgen therapy practically all cases receive arsenic and some have been exposed to altitude sun.

From 1913 to 1925, 20 cases of lymphogranulomatosis were observed at the Leipzig Clinic. The data on these cases are presented in the form of a table. Eight cases were lost to sight after the first or second successful series of radiation treatments. Of the remaining 12 there were 4 which showed practically no response to the treatment and died in six months. The remaining 8 presented a chronic course of the disease with an average duration of life from the beginning of treatment of 2.5 years, with an average freedom of seven months from recurrences.

BURNAM, CURTIS F. Hodgkin's disease, with especial reference to its treatment by irradiation. *J. Am. M. Ass.*, Oct. 30, 1926, lxxxvii, 1445–1452.

An analysis is given of 173 cases treated at the Howard A. Kelly Hospital, Baltimore, between 1913 and 1925. In this group there were 118 males. A surprising absence of tuberculosis in the family and personal histories was noted. The mouth and nose, the respiratory tract and the intestinal tract in the order named are the gates by which the disease reaches the glands. The four outstanding complaints were tumor masses, fever, weakness and skin itching. Very acute cases, especially of the intestinal type, last only a few weeks; chronic cases extending over years have been long recognized and generally regarded as rare. In the present series the average duration of the disease up to the time of treatment was one year and five months. Length of life as well as clinical manifestations are greatly modified by treatment, hard work, improper nutrition, intercurrent infections, etc. Death is frequently due to terminal secondary infections Sometimes there is a gradual exhaustion and death from cachexia.

It is now generally agreed that radiation therapy is by far the most effectual means of combatting this singularly lethal affection. The cases in this series with few exceptions were treated with radium alone. The author finds that the reduction of glands whether deep or superficial is much more rapid from radium than from deep roentgen treatment. Furthermore the effects are obtained with much less general upset to patients. It seems that a very much smaller percentage of gamma rays is effectual than of roentgen rays in producing similar results. A sufficient amount of radium is essential if it is to be used at all. Probably 500 mg. is a minimum when mediastinal and abdominal treatments are given. The technique employed in this series of cases has varied a good deal. The technique recommended is a uniform distance of 2 inches from the skin, a filter of 1 mm. Cu and 1 mm. lead in all the superficial gland areas, and in the deep areas unless cross firing is feasible, a distance of 4 to 5 inches. The dosage at the shorter distance is 4 gm-hr. At the greater distance from 15 to 25 gm-hr. This is about 50 per cent of the erythema dose. The aim is to give the involved tissues about 25 per cent of a skin erythema dose. In 28 patients discharged as cured the actual dosage varied from 5 to 134 gm-hr. (one case received only roentgen treatment and operation). The interval between treatments or series should be two months or longer.

In the roentgen-ray treatment the important consideration is to choose portals of a size as small and of a shape as precise as are consistent with inclusion of all the diseased volume. Much can be done to protect parts of the body that should not be irradiated. The author prefers a distance of 50 cm., with rays filtered through aluminum, copper and rubber. The treatment to an area is very short. The rays are produced by a Coolidge tube, operated at 240 kv. and 40 ma. The author is convinced that certain cases of Hodgkin's disease are not only palliated from symptoms of the disease but cured from the clinical standpoint. Recurrences are very common and frequently do not respond in later treatments to the same degree that they did in the first treatment. In this series of 173 cases there were 2 patients who declined treatment. In only 11 was there no clinical improvement whatever and all of these were very advanced. One hundred and ten of the patients have died of the disease. The average life of these after treatment was two years and ten

months. The average duration of the disease up to death was four years and three months. Nine patients are still under treatment with evidence of disease; the average period in these cases is four years and three months. There are 28 patients classified as clinically cured, although 2 are dead, dying in the ninth year from apoplexy and with years of freedom from any signs of the disease. In this group of cured cases the average duration of life since treatment was undertaken is five years and two months.

Desjardins, Arthur U. Stimulation and immunity in radiotherapy. *J. Am. M. Ass.*, Nov. 6, 1926, lxxxvii, 1537–1541.

Taking into consideration the large amount of evidence indicating that continued acceleration of cellular metabolism does not follow irradiation, it must be concluded that (1) cells and collections of cells, such as organs or tumors in plants and animals, cannot be stimulated in the sense that they acquire greater ability to function in a normal manner; (2) any such apparent stimulation is only a transient phase invariably followed by more or less pronounced functional or organic deterioration; (3) the assertions of a few that such stimulation does take place must be based on the insufficient duration of their observations, a misinterpretation of the results of their studies, on complicating circumstances the nature of which is not clear or on abuse of the meaning of the word stimulation. Where, for instance, over-exposure to roentgen rays causes degeneration leading to malignant growth, the effects cannot be termed stimulation in the proper sense. It is in this case an alteration of a normal to an aberrant function due to chronic irritation.

The mass of evidence available indicates rather conclusively that the cellular changes brought about by radiation in the case of malignant neoplasm are of the same order as those produced in normal cells, subject, of course, to the modifications imposed by differences in cell metabolism peculiar to the variety of malignant process. Therefore, how can one speak of the biologic effects of radiation as being due to an immunity reaction? On the contrary, the major factor in the effect of radium and roentgen rays on cancer cells is a direct one. It consists of at least two overlapping and interrelated features; a direct action on the cells of the tumor, this action being most pronounced on those cells which happen to be in the most vulnerable stage, and a direct action on the endothelial cells lining the blood vessels supplying the tumor itself, as well as those supplying the normal tissues in the exposed zone.

Some radiologists have professed that the proliferation of connective tissue can be directly stimulated by radium or roentgen rays. Such a claim is regarded as preposterous. It is a question whether or not Ewing is wholly right in thinking that the clinical results of radiotherapy of tumors "are not usually due to the direct killing effect of radiation, but are generally brought about indirectly and mainly by interference with the circulation." However, since the action of radium and roentgen rays both on the tumor cells and on the endothelium and other cellular components of blood vessels (leading to their obliteration) is directly due to those rays, and since immunity has been shown to be a negligible factor in the regression of tumors, one is forced to consider the morphologic alterations observed in tissues as a direct effect of radiation.

Farrar, Lilian K. P. The reaction of the tissues to radium in treatment of cancer of the cervix and the importance of lacerations in producing cancer in this location. *Surg., Gynec. & Obst.*, December, 1926, xliii, 719–723.

In the cervix, the reaction to radium treatment is so nearly uniform that the appearance of the cervix each month after treatment can be predicted if the case is progressing favorably; one can also tell when the maximum effect of radium has been reached and a further dose is needed. Cancer of the cervix when treated by radium shows a progressive course toward contraction of the cervix and inhibition of the cancer cells in well-defined stages of (1) hyperemia; (2) slough; (3) healing, and (4) contraction.

Stage of Hyperemia. One week after the initial dose of radium the tissues of the cervix are intensely red and hyperemic. The blood vessels are engorged with blood and it is for this reason that the author does not consider the case should be irradiated if an immediate operation is imperative.

Stage of Slough. One month after irradiation the cervix usually shows an extensive green slough and a foul discharge from the broken-down carcinoma. This slough must be entirely separated from the cervix before a hysterectomy can be performed without great danger of peritonitis resulting from cutting into this necrotic tissue. It is emphasized that not every case progresses at the same rate of speed, even when favorable results are obtained.

Stage of Healing. This is reached usually two months after irradiation. The appearance of the cervix is now completely changed as the slough has separated leaving a smooth, clean, dusky red cervix which may be somewhat glazed but has clinically no evidences of carcinoma. This is followed by *a stage of contrac-*

tion in about a month. The development of connective tissue which is excited by irradiation markedly reduces the size of the cervix and also the vault of the vagina. Large carcinomatous growths or even craters become contracted to a normal or smaller than normal cervix and the vault is as narrow as that seen in senile vaginitis. Following this occurs the *final stage*, that of *marked contraction*. The increasing amount of connective tissue squeezes the tissues of the cervix until the latter is finally so shrunken as to leave a superficial resemblance to an amputated organ. Little or no vault to the vagina is left and the mucous membrane is pale, with only an occasional blood vessel in sight. It is only when this stage is reached that the result of radium treatment is regarded as clinically satisfactory.

An inspection of the cervices invaded by carcinoma revealed the great frequency with which lacerations were present. A study was made of 300 consecutive case histories of cancer of the cervix at the Woman's Hospital, New York, to determine the incidence of pregnancy. In 288 of these cases (96 per cent) pregnancy had been present. One hundred and fifteen of the patients had had 5 or more pregnancies, and 35 of these had had from 10 to 23 pregnancies. Nearly all the histories showed hard labors or instrumental deliveries, and frequently there was the specific statement that the patient had been badly torn. In 288 cases of cancer of the cervix 11.1 per cent of the patients had had the last pregnancy less than five years before entering the hospital for cancer of the cervix, and 20.3 per cent had had the last pregnancy less than ten years before entering the hospital with cancer of the cervix.

A careful palpation and visual inspection of every cervix immediately after the confinement and an Emmet trachelorrhaphy performed for lacerations in the cervix would, it is believed, lessen the danger of cancer development in the cervix later. Intermediate or secondary repair of the lacerations should be made when conditions do not warrant an immediate repair.

HOLZKNECHT, G. The intensification of the roentgen effect by means of intravenous dextrose injections according to the method of E. G. Mayer, M. D. *Acta radiol.*, December 15, 1926, v, 561–564.

A brief summary is given of observations upon the increased effect on carcinomas of roentgen rays administered after an intravenous injection of dextrose. A much greater number of cases are benefited by this combined treatment, a favorable effect rapidly ensues and a maximum result is quickly obtained. All the other methods heretofore recommended for increasing the sensitivity of cancers to radiation treatment have had no effect worth mentioning.

KENNEDY, WILLIAM H. Radium treatment of epithelioma of the ear. *Radiology*, September, 1926, vii, 249–252.

It cannot be too strongly emphasized that no single form of therapy is applicable to all cases of epithelioma of the ear. In addition to the patient's general condition, the other factors that have a determining influence are the stage of the process, the type of previous treatment, if any, and the location, whether external or internal. A large percentage of the cases are usually presented in an advanced stage.

The author has employed in his cases applications of 50 mg. radium element filtered through 0.5 mm. silver, 1 mm. brass, 1 mm. lead and 2 mm. soft rubber. This was applied for a period of two hours daily for four consecutive days, the author's head band applicator being employed to procure 3 mm. distance from the surface of the growth. Pictures are shown of 4 cases before and after radium treatment, in which the ear epitheliomas had apparently disappeared entirely.

MACKEE, GEORGE M., and ELLER, JOSEPH J. Variations of cutaneous toleration for roentgen rays. *J. Am. M. Ass.*, Nov. 6, 1926, lxxxvii, 1533–1537.

There is reason to believe that telangiectasis never develops in the absence of an antecedent reaction. This reaction may consist of only an exceedingly mild and evanescent erythema, a reaction that may pass unnoticed, or may be masked as well as enhanced by topical applications. It is desirable to avoid visible cutaneous reactions when administering roentgen rays and radium unless such reactions are therapeutically indicated, because even a mild reaction may be followed occasionally by undesirable sequelae. An occasional individual, especially an adolescent blonde, will exhibit an erythema following adminstration of one-fourth skin unit of unfiltered roentgen rays.

Patients should be carefully inspected during a course of radiation treatment for the premonitory signs of impending reaction. It is preferable not to use any topical application that might increase the effect of irradiation or that might mask a reaction, or that might cause erythema or exfoliation.

A total of 210 patients was tested with $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ unit doses unfiltered. The areas exposed were about the size of a postage stamp and they were situated either on the inner sur-

face of the thigh or on the flexor surface of the forearm. The unit of measurement corresponded with the so-called standard erythema dose. The results are given in the following table:

Complexion	No. of Cases	Erythema from Dose in Skin Units			Pigmentation from Dose in Skin Units		
		¼	½	¾	¼	½	¾
Dark skin	162	7	20	36	82	90	90
Fair skin	48	4	11	18	15	16	19
Totals	210	11	31	54	97	106	109

The numbers in this table refer to the number of cases, male and female, exhibiting the response. The results appear to have been the same with filtered and unfiltered radiations. The testing of a patient's skin for tolerance before instituting a course of radiation treatment may possibly add an additional safety factor to the technique.

Mann, Lewis, T. Results of x-ray therapy of malignant growths of the urinary tract. *Surg., Gynec. & Obst.*, October, 1926, xliii, 529–534.

The cure of malignant growths of the urinary tract by deep roentgen therapy is a very infrequent occurrence. Alleviation of symptoms occurs almost as infrequently as cure and is in most cases temporary. There does seem to be a greater prolongation of life in cases treated with deep roentgen rays than in cases not so treated. These are the conclusions drawn from a statistical analysis of cases observed at the Mt. Sinai Hospital, New York, and from private practice. Some of the cases were treated with deep roentgen rays alone, some by combined surgery and roentgen therapy, some by combined radium and roentgen therapy and still others by a combination of all three. The radiation treatments were given at various hospitals and in private practice. The technique used was essentially the same in all instances, high power machines with proper screening being used.

Three tables are presented in which the details as to diagnosis, operation, radiation therapy and result of treatment are noted. In the first group are 11 cases of kidney tumors, 4 of which could not be traced. Two of the cases lived three years or longer, 3 lived two years or more, and 4 lived one year or more after roentgen treatment. In the group of bladder tumors there were 17 carcinomas and 2 papillomas. The latter did not respond to fulguration with high frequency current. Relief of symptoms after deep roentgen therapy was obtained in only 3 of the 17 cases of carcinoma. There were recurrences in 13 cases. Life was not prolonged and the mortality was about the same as if no roentgen therapy was used. There were no cures in this series. The third group comprised 12 cases of prostatic carcinomas. Deep roentgen rays produced no cure and there was no evidence that life was prolonged by radiation treatment in this series. In 2 cases symptoms of dysuria, hematuria and frequency were relieved for some time, while in the remainder relief was but temporary or entirely absent. There was no permanent decrease in the size of the tumor mass in any case. It is to be noted that none of the tumors grew rapidly after roentgen therapy was started and obstruction to urination did not occur.

Masson, James C. Myomectomy, hysterectomy and radiotherapy in fibromyoma of uterus. *J. Am. M. Ass.*, Nov. 6, 1926, lxxxvii, 1530–1533.

The danger of a fibromyoma becoming sarcomatous or initiating a carcinoma in the uterus is slight; sarcoma develops in about 2 per cent and carcinoma in about 4 per cent of patients treated surgically. It seems that radium is advised too frequently in the treatment of fibromyoma both by those who have a limited amount of radium at their disposal and those inexperienced in its use. Surgery is often a more conservative treatment than the administration of even small doses of radium or roentgen rays.

Radiotherapy is indicated for all patients over forty, who have fibromyomas less than 15 cm. in diameter with metrorrhagia as the chief complaint. It is also indicated if the patient is under forty and refuses surgical removal, or if a major operation might carry an added risk. It is also indicated in all cases of fibrosis uteri or cases in which there are essential uterine hemorrhages.

Surgical treatment of fibromyomas is indicated for most patients under forty; for most patients with pain or irritability of the bladder; for patients with tumors more than 15 cm. in diameter; for those whose tumors are of the pedunculated or submucous type or undergoing degeneration or inflammation; for those whose tumors may not be fibromyomas and for those with complications that require the opening of the abdomen. Abdominal myomectomy is the operation of choice for a majority of patients under forty. Vaginal myomectomy is indicated if the fibromyoma presents through the cervix.

Abdominal hysterectomy is especially indicated in cases showing marked secondary anemia when further loss of blood might have serious consequences. In such cases transfusion is given, and provided there is no reaction it is

followed in twenty-four hours by hysterectomy, a procedure which is safer than radium, as bleeding sometimes continues for several weeks after irradiation and demands repeated transfusions. Furthermore, if the tumor is degenerated cachexia will be increased.

It is emphasized that there are well-defined fields where either surgery or radiotherapy exclusively can yield satisfactory results. The best interests of the patients are disregarded by the therapist who insists on radiotherapy indiscriminately just as much as by the one who adheres exclusively to surgery.

A report is given of a case observed in a woman aged fifty-one who had a uterus about the size of a three months' pregnancy and containing multiple small fibromyomas. Radium was advised but the patient refused any treatment except surgical. Total abdominal hysterectomy was performed with removal of both tubes and ovaries. Two distinct squamous cell epitheliomatous nodules were discovered by the pathologist in the left ovary. In this case much valuable time would have been lost had the patient not insisted on surgical treatment.

MAYER, ERNST GEORG. Considerable increase in the roentgen effect on tumors. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 546–547.

A brief statement is given concerning the effect of intravenous injection of hypertonic solutions of dextrose in intensifying the effect of roentgen rays upon tumors. Four cases in which these effects were produced are briefly cited. The effects produced do not seem to be due to the action of the hypertonic sugar solution alone. Apparently, the metabolic condition of the tumor cells is in some way altered so as to make them vulnerable to the effects of the rays.

PLAUT, ALFRED. The relation of prognosis to the histological findings in carcinoma of the cervix. *Surg., Gynec. & Obst.*, October, 1926, xliii, 450–458.

There is at present no reliable basis for a histological prognosis in cervical carcinoma. The histological picture of cancer of the cervix does not permit the establishment of well-defined groups according to the type of cancer cell. The establishment of relations between cell type and malignancy is impossible at present owing to the lack of exactly definable cell types. It may be suggested that a classification on the basis of radiation sensitiveness might be made; but since the effect of radiation is three-fold, namely, caustic destruction, autolytic degeneration and growth retardation, the problem of classification becomes complicated.

Constitutional factors must be considered in determining prognosis; and the influence of age must be studied over again since existing data are unsatisfactory. The clinical classification of carcinoma of the uterine cervix is still the best aid in making a prognosis; and the general histological aspect of the tumor may be an aid.

These conclusions are the result of a study of the material from patients admitted to the Woman's Hospital, New York, for radium treatment of cervical carcinoma. The classification of Martzloff was followed in an attempt at histological prognosis. The analysis of over 149 cases shows, however, that prognosis on the basis of cell type is not possible in cervical carcinoma.

SCHMITZ, HENRY, and LAIBE, JOSEPH E. F. Roentgen-ray treatment of inoperable carcinomas of the urinary bladder. *J. Am. M. Ass.*, Nov. 6, 1926, lxxxvii, 1541–1544.

From January, 1915 to April, 1925 fifty-three cases of clearly inoperable and advanced primary carcinomas of the urinary bladder were treated by three different methods: 21 cases with radium; 19 cases with a combination of cautery and radium or roentgen rays, and 13 with roentgen rays alone. In the last group the rapid and complete arrest of growth and the subjective relief in most of the patients was quite remarkable.

The radium treatment in the first group of 21 cases was given with capsules or needles applied to the growth either through a suprapubic cystotomy incision or with Young's cystoscope. Sixteen primary and 5 recurrent cancers were thus treated. The average amount of gamma ray milligram-element-hours applied was 2400, the highest being 5200 and the lowest 900, the amount depending on the size of the growth and the distance between the capsule and the tumor surface. Of the 16 primary cases treated, one patient has been anatomically well for eleven years and one for six years. The average duration of life after treatment was somewhat less than eighteen months in the primary cases and eight months in the recurrent cases.

Combined surgery and irradiation was tried in 11 primary and 8 secondary cancers. The surgery consisted of destruction of the tumor with electric cautery or with diathermy and the radiation treatment included radium and roentgen rays. The intensity of the roentgen dose at a depth of 10 cm. was 32 per cent of the surface intensity, the rays being filtered through copper and aluminum. The results of this "combination" therapy were very

disastrous. The average duration of life in the primary cases was four months and in the secondary cases eight months.

Since March, 1923, massive short-wave roentgen rays have been employed exclusively. The factors employed were 211 kv., 25 ma., determined with a Seemann spectrograph, 0.75 mm. Cu plus 1 mm. Al, 65 cm. focal skin distance, 15 × 20 cm. field. With these factors 130 per cent erythema skin dose is delivered in thirty-five minutes. The intensity at a depth of 10 cm. is 48 per cent of the surface intensity. With the aid of iso-intensity curves and the measurements of the anteroposterior and transverse diameters of the pelvis a roentgen dose of 130 to 150 per cent of the erythema skin dose is applied to the bladder cancer. The number of fields depends therefore on these calculations.

Seven primary and 6 recurrent cancers have been treated by this technique up to April 1, 1925. Four patients with primary and 3 with secondary cancers are well and free from symptoms at the time of this report; one patient after thirty-four months; 2 patients for twenty-six months; 2 for twenty months, and 2 for fourteen months. One patient died two months, 1 six months and 1 seven months after treatment. Three cases are inconclusive. The good results obtained with short wave roentgen-ray treatment may be ascribed to (*a*) the homogeneous penetration of the cancer bearing area with a known roentgen-ray dose; (*b*) the radiation sensitiveness of the cell types composing the bladder cancers; and (*c*) the absence of trauma and local irritation in roentgen-ray therapy.

SCHNEIDER, GEORG HEINRICH. Undesirable effects of roentgen therapy of benign gynecological disease. *Strahlentherapie*, 1926, xxii, 289–300.

The author was unable to confirm the result of Heidenhain and Fried who employed "minimal irradiation" in the successful treatment of inflammatory gynecological conditions. A 5 per cent skin erythema dose was without effect. This of course does not apply to the well-recognized favorable effect of minute amounts of roentgen rays in tuberculous conditions. It was found that the so-called stimulative ovarian irradiation of gynecological inflammations especially ascending gonorrhea is often accompanied by undesirable indirect radiation effects.

The temporary castration treatment with approximately 27.5 per cent of the skin erythema dose has been found to be a hopeful therapeutic procedure in the treatment of chronic gonorrheal infections of the adnexa. In addition to the desired direct repressive effect on ovulation which is a therapeutic desideratum there may also appear an undesirable indirect effect. Endocrine menorrhagic disturbances due to the rays may complicate the inflammatory processes in the pelvic organs.

SCHNEIDER, GEORG H. Studies of biologically equivalent radium and roentgen radiations. *Strahlentherapie*, 1926, xxii, 460–483.

From comparative valuation of roentgen and radium temporary castration doses from the standpoint of duration of amenorrhea and influence of age, dose and readiness of response of the organ, it was possible to determine biologically equivalent quantities of radium and roentgen rays. The results serve as a basis for avoiding overdosage when the rays are employed in combination. The values obtained cannot be compared absolutely with one another except in the sense that the equivalent values are expressed in equal biological effects. Taking as a unit of biological action menostasis of one month's duration, it is possible to evaluate the importance of individual factors. On the basis of clinical data the author presents "isodose" tables for radium and roentgen rays, for women of various age groups between twenty and sixty years and for brief amenorrhea and prolonged amenorrhea. Assuming a radium preparation containing 50 milligrams radium element filtered through 1.5 mm. brass and 1 mm. lead free rubber, it was found that 68.3 mg-el-hr. corresponded to 4.5 per cent roentgen skin erythema dose, and 150 mg-el-hr. to 6.6 per cent skin erythema dose. These values apply to a single dose with the radium applied for twelve to twenty-four hours. With higher doses and a more prolonged effect the relative values were altered (42.7 mg-el-hr. corresponded to 1.2 per cent skin erythema dose and 65.8 mg-el-hr. to 1.5 per cent skin erythema dose to produce a unit biological effect).

WATERS, CHARLES A. Deep roentgen-ray therapy in the treatment of carcinoma of the bladder. *J. Am. M. Ass.*, Nov. 13, 1926, lxxxvii, 1618–1620.

A summary is given of the results obtained in the Brady Urological Clinic, Baltimore, with deep roentgen therapy of bladder carcinoma in 120 cases.

The best treatment of superficial papillary carcinoma, localized or extensive, is a combination of deep roentgen therapy with radium applied directly to the surface of the growth. Radium alone has been unsuccessful in this type of case. The combination treatment appears to yield better results if the tumor has received 600 to 800 mg-hr. radium before roentgenization is started. By a combination of

radium with roentgen rays most of these tumors can be destroyed with minimum of injury to the bladder, and in many cases with little or no irritation of the mucosa.

In infiltrating carcinomas, if still operable, radical resection appears to offer the greatest chance of complete cure. In the inoperable cases, if it is possible to apply radium directly to the growth, the combined radium and deep roentgen treatment should be tried. If this procedure does not yield results it may be necessary to resort to implantation of radium needles. If the growth is so extensive that more than 2500 mg-hr. is necessary to entirely destroy the cancerous area by implantations, this method should not be considered. Diathermy has been tried but no conclusions as to its efficacy have yet been reached.

The great tendency for bladder tumors to recur makes it necessary to have the patients return for re-examination frequently.

Xarpell, Cusi. The employment of paraffin as a diffusing substance in deep roentgen therapy. *Strablentberapie*, 1926, xxii, 237–262.

The erythema dose cannot be regarded as a precise measure so long as its value cannot be expressed in physical equivalents. It is hard to expect uniformity until this is attained. In the administration of a dose one of the prime essentials is that it shall be uniformly and adequately distributed throughout the whole zone to be irradiated. In many cases this necessitates the use of a material for making the irradiated zone of uniform density. At the University of Barcelona the author has employed since 1921 paraffin which appears to be entirely satisfactory for the purpose.

In the matter of roentgen therapy, it has been the experience of the author to avoid any technique which approaches too close to the maximum tolerated dose of the tissue. Preference is given to irradiation with a minimum possible destructive dose so that tumor cells may be destroyed while the healthy cells in the vicinity are protected so far as possible.

MISCELLANEOUS

Benecke, Hans. Cooling of the anticathode of diagnostic electron tubes. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 487–490.

The fact that when heated sufficiently the focal spot (not the entire anticathode) in electron tubes exhibits valve action is explained by the rapid cooling of the focal spot, which the author has demonstrated photographically. This was accomplished by shifting the film while the camera was focused upon the anticathode. A series of dashes was recorded corresponding to the moments of incandescence of the focal spot on the anticathode. One photograph was taken with the roentgen tube operated on alternating current and a second with the same tube operated on rectified current (50 cycles). The photographs show not only that the focal spot on the anticathode is incandescent for a very short time but also that the frequency of the incandescence was greater when the tube was operated on rectified alternating current. This is additional direct proof that the operation of diagnostic tubes with direct current is more advantageous.

Boyden, Edward A. Behavior of human gall-bladder during fasting and in response to food. *Proc. Soc. Exper. Biol. & Med.*, November, 1926, xxiv, 157–162.

By roentgenological evidence from patients and experimental animals the author has found support for the following conclusions: (1) The mammalian gall-bladder, at least in man and in cats, is able to expel all its fluid contents by the contraction of its musculature; (2) after meals this contraction is so timed as to meet the first requirements of digestion; (3) in cats the gall-bladder responds to such changes in the circulation as are produced by blood transfusions and to such superficial lesions as are caused by shaving and by cutaneous incisions; (4) adrenalin is the most powerful excitant of gall-bladder contraction yet found.

One of the methods employed was the making of long series of human cholecystograms at fifteen-minute intervals after meals. During the first 240 minutes the gall-bladder of the human subject assumed the shape of a flaccid organ capable of distortion by external pressure. Fifteen minutes after ingestion of cream the wall tightened and there was revealed an actual expulsion of iodized bile into the cystic duct. During the preceding period of fasting there occurred one marked contraction as a result of which the volume of the gall-bladder shrank from 4.15 cubic inches to 2.17 cu. in. This happened at the only time that the patient complained of hunger pangs. This finding raises the question as to whether contraction of the gall-bladder may not at times subserve another function than that of digestion.

In order to test the effect of milk ingestion upon the gall-bladder, another volunteer patient was given a pint of milk and then cystographed at frequent intervals for three hours. In the first hour over 12 c.c. of bile was expelled from the gall-bladder; in the second hour less than 1 c.c.; and in the third hour

none. It would therefore appear that the digestion products of milk do not induce effective contraction of the gall-bladder. The substance which stimulates the biliary reservoir would thus appear to be some element in undigested food such as neutral fat. When half a pint of cream was tried on the same individual no greater effect was produced in spite of the greater amount of the fat. A comparison of the effect of these two diets suggests that the distended gall-bladder is a trigger mechanism which is set off by a moderate amount of neutral fat, the quantity of which is not important beyond a certain minimum. To confirm this idea, periodic feeding of milk was tried. The first pint induced a marked expulsion of bile decreasing the volume in one hour from 2.8 to 0.55 cu. in.; as the gall-bladder began to fill a second pint was ingested, decreasing the volume in the next hour and a half to 0.33 cu. in.; finally a third dose diminished the contents to 0.1⁻ cu. in. The reason that egg yolk is so effective in causing eventual collapse of the gall-bladder is that successive portions of its fatty substance may continue to be discharged into the duodenum for a long period; and after the gall-bladder has emptied itself (two to three hours after a meal) the subsequent flow of hepatic bile tends to keep the sphincter papillae open and prevent filling of the reservoir. However, the ingestion of food is most effective when the gall-bladder is distended, apparently because the response of smooth muscle in this organ is greatest when it is stretched.

This initial reaction to many foods containing a moderate amount of fat emphasizes the importance of the gall-bladder as an organ of digestion; and since it plays so consistent a rôle, there should be an end to the indiscriminate cholecystectomy of the last decade. The fact that it is not a vital organ is no argument against its utility.

DESSAUER, FRIEDRICH. Comments on Professor Opitz' citicism of the heat point hypothesis of Dessauer. *Strahlentherapie*, 1926, xxii, 189–190.

The experiments cited by Opitz as casting doubt on Dessauer's hypothesis are considered inapplicable. In the examples cited by Opitz (failure to deflagrate phosphorus and gun cotton) the speed of reaction is greatly dependent on the temperature, and to produce deflagration it is necessary that the total heat delivered be in excess of that given off by conduction, radiation, etc.

Dessauer points out that in the case of the "heat points" postulated, each point is *isolated* and, as compared with the particles of phosphorus, widely separated from other similar points. As a consequence radiation and heat conduction away from these points occurs possibly much more rapidly than the reaction. Moreover, the duration of these heat points is very short. In addition, the biological effects following the production of the heat points depends especially upon the presence of certain structures, large molecules produced from complexes of limited degrees of freedom. In such cases the absorption of roentgen rays in the form of heat points results in increased motion of translation of certain of these molecules. In the examples cited by Opitz this condition was not approximated.

FABRE, PH., and DESGREZ, H. The use of lamps with two electrodes in studying chronaxia. *J. de radiol. et d'électrol.*, October, 1926, x, 459–462.

Chronaxia is the time necessary to obtain muscle stimulation by means of a constant current double the threshold of voltage. It is generally believed that the intensity is doubled by doubling the voltage at the ends of the circuit. But this is not true because of contra-electromotor forces originating in the organism. These forces do not double when the electromotor force applied is doubled so that the current which is really obtained is stronger than it would be according to the rule. To overcome this difficulty the authors use a lamp with two electrodes, the construction and application of which is described in detail with drawings. They give a table of the results obtained with this lamp which shows that the chronaxias obtained by its use are 2, 3 or 4 times as great as those obtained by the ordinary method of measurement. They intend to publish a later paper showing in detail the cases where this rule does not hold good. Another advantage of this method is that ordinary industrial constant currents can be used.

GABRIEL, G. The effect of roentgen irradiation on animal organs. *Strahlentherapie*, 1926, xxii, 107–124.

The irradiation of internal organs results in changes in tone of the vascular system which appear early and are similar to those occurring in the skin. By means of certain suitable irradiations it is possible to produce in the animal kidney a progressive series of changes ranging from mild vascular change to the picture of primary contracted kidney.

The same early changes in vascular tone above noted are also produced by roentgen irradiation of the liver, spinal cord and adrenals. The changes produced in the adrenal capsule present the picture of an epirenal cachexia.

These observations were made upon cats, dogs and rabbits. The roentgen doses were carefully controlled both qualitatively and quantitatively and the tissues were subjected to close histologic study. In some of the cases the perfused kidney preparation was employed, and the effects noted upon the rate of flow of the perfusing fluid through the organ.

Gassul, R. A method of treatment of bronchial asthma by the spleen diathermy process. *Strablentherapie*, 1926, xxi, 685–689.

Bronchial asthma, in the light of recent studies on anaphylaxis, appears to be a syndrome of general hypersensitiveness and increased reactivity of the respiratory apparatus toward various heterogeneous substances or physical agencies. It may therefore be described as a toxic idiopathy, constitutional in origin, of certain processes controlled by the vegetative nervous system.

In order to decrease hypersensitiveness a suitable desensitizing agent or sensibilogen is required. Owing to the number of different things that can produce bronchial asthma, solution of the problem would appear to be very complex. Without trying to discover specific anaphylactogens, the author sought some procedure for stimulating antibody formation in the individual so as to desensitize him. The author therefore directed his attention to the spleen as the most powerful antibody-producing organ, and by means of diathermy currents which induce active hyperemia sought to activate and increase spleen function.

Therapeutic experiments along this line were begun in September, 1924. The first diathermy treatments frequently caused very pronounced attacks which later subsided, and disappeared entirely after ten to thirty treatments. The technique was as follows: Apparatus, Neo-Thermo-Flux, (Reiniger, Gebbert and Schall) 120 v., a.c. The electrodes (dry) 8 x 7 sq. cm. were applied to the splenic region, in front along the line connecting the sternoclavicular joint and the free end of the 11th rib; and in back along the 11th, 10th and 9th ribs. Usually 0.8 to 2.0 amp. were administered at a sitting. Before an actual treatment, experiments were performed in which the manipulations were gone through without actually delivering any treatment in order to rule out suggestion. During treatment, there was continual observation of the subjective and objective condition of the patient, the blood condition and blood coagulation. Some of the patients have been observed for six to fourteen months since being relieved of their asthma. The time of observation is naturally too brief for a final conclusion, but the diathermy process seems to deserve serious consideration in the treatment of bronchial asthma.

Glocker, R., and Kaupp, E. The accuracy of the spectrographic method of measuring voltage. *Strablentherapie*, 1926, xxii, 160–171.

Seemann spectrographs were taken by the pinhole camera method with a slit 0.25 to 0.50 mm. wide. Evaluation of the photographic spectra by means of microphotometric determinations always gave the same value for the voltage within ±1 per cent at 180 kv. for the various blackenings of the photographic plate for wave lengths ordinarily used. This applies to films taken with and without intensifying screens. A direct measurement of the plates by means of a rule yields the correct values for the voltage within a few per cent, provided the plates are very much darkened. The plates with low light threshold values are suitable for this purpose, as are also powerful intensifying screens. Excessive exposure (so long as solarization does not take place) is not disadvantageous, because it does not introduce any danger of over-estimation of the potential. On the other hand, under-exposure gives values which are too low. For the use of the practitioner it is recommended that sample plates be furnished with each spectrograph so as to indicate the degree of darkening necessary for the direct measurement.

A description is given of a measuring device which can be easily adjusted to a microscope (a movable slit controlled by micrometer screw), which permits the estimation of the potential with an error of 1 to 2 per cent at 180 kv., and which is independent of the degree of blackening of the plates except in the case of under-exposed plates.

Hickey, P. M. Important considerations in planning an x-ray department. *Radiology*, August, 1926, vii, 104–108.

The author concludes that in general the planning of a roentgen department presents problems peculiar to the type of institution where it is to function. While general conclusions can often be drawn and general plans followed to advantage, yet each department demands the most careful study: (1) to realize the general scope of the problem, and (2) to work out the various details with the utmost care.

As nearly as possible units of construction should be followed so that sub-departments can be shifted if the growth demands or if the character of the work should change. A sufficient number of dressing rooms should be made available, the most efficient type being one

which is placed between the reception room and the exposure room.

If possible, separate rooms should be provided for gastrointestinal work, pulmonary roentgenoscopy and surgical roentgenoscopy. Special attention should be given to the matter of ventilation and heating of the various rooms and to the illumination of the roentgenoscopic room.

In planning the electrical power supply the roentgen-ray department should have a separate outside transformer with an individual service to the various outlets in the department. Under no circumstances should the roentgen department derive its power current from transformers which also supply current for other power plants within the hospital.

To prevent radiation escaping from one room to another the author believes it is much better to surround the tube with efficient shields and to rely for further protection upon barium plaster walls and barium plaster floors. Barium cement tiles in the walls or partitions constitute a further aid in protection.

Hinman, Frank, and Redewill, Francis H. Pyelovenous back flow. *J. Am. M. Ass.*, Oct. 16, 1926, lxxxvii, 1287–1293.

Pyelovenous back flow is the name applied to the phenomenon of drainage into the venous system from the renal pelvis under certain conditions of back pressure. This condition is not of uncommon occurrence clinically, and may be readily demonstrated experimentally. The most common place of occurrence is at the fornices of the minor calyces into the interlobar venous spaces. In the manner of occurrence the following are probably of importance: diapedesis, osmosis and permeability of the membranes.

Each of the innumerable mediums that have been suggested for pyelographic purposes has its own colloidal content and its own peculiar ionization reaction to the membranes with which it comes in contact. Consequently different types of pictures may be expected corresponding to the differences in isotonic reactions of these different mediums. Another factor of importance is the individual variation in penetrability of the membranes.

This phenomenon of pyelovenous back flow is of clinical significance in relation to pyelography both to accidents following the use of toxic substances and to defects of filling in the pyelogram which may lead to misinterpretation. The manner in which pressure is applied is of the utmost importance. The character of the kidney with respect to age and disease is also of importance. Greater ease of back flow is to be expected in childhood and in certain disease conditions.

Holthusen, H. The present status of physical methods of dose measurement. *Strahlentherapie*, 1926, xxii, 1–37.

A general review of the question is presented. The conceivable difficulties in the measurement of the quality and quantity of roentgen rays arise from the fact that the attempt is made to obtain a comparative measurement of heterogeneous mixtures of radiation of varying hardness. The measurement of the *energy* of roentgen rays of different wave lengths is not practically feasible at present owing to the difficulties of the method. The assertion that the fundamental basis of the standard dosimetric unit is dependent exclusively upon the energy measurement will remain unjustified so long as it is doubtful whether the biological effect of the roentgen rays of varying wave lengths is directly proportional to the absorbed energy. The measurement of dosage is affected by the estimation of one of the chemical or physical effects called forth by the roentgen rays. Other things being equal, that dosimetric reaction is given preference which runs parallel to the biological radiation effect over the greatest range of wave lengths. The chemical methods of measuring radiations, in addition to being unable to yield sufficiently sharp readings of the intensity of the reaction, suffer primarily from the disadvantage that the ratio of the absorption to the tissue response undergoes sudden changes due to selective absorption within the range of radiations ordinarily employed in practice.

In contrast to this the actual absorption, i.e., pure absorption, which is capable of releasing photoelectrons and which is increased by that portion of scattering responsible for the recoil electrons, this true absorption runs entirely parallel for air and tissue throughout the whole range of wave lengths employed in practice. At any rate this holds for air ionization which, with the absolute roentgen unit based upon it, merits preference over all other dosimetric reactions not only for reasons of exact definability, but also because of its special adaptability as an equivalent of the tissue dose. Amongst the other dosimetric reactions, the irregular percentage participation of recoil electrons (with small ionization chambers, the participation of the radiation from the wall being more effective than the incomplete utilization of the air radiation), causes deviations from the expected proportionality of the absorption by air and tissue on the one hand, and the dosimetric reaction on the other.

The variations in the sensitiveness of various dosimeters between 60 and 186 kv. (half value layer of copper between 0.05 and 1.73 mm.) referred to the measurements obtained with a barrel chamber are paralleled by the deviations predicted by theory. The technical difficulties of the measurement with purely air ionization, and the difficulties of determining the absolute R measurement are explained as due to the peculiar behavior of the roentgen rays upon absorption. There are discussed the conditions under which the standardization of the roentgen unit can be made and the possibilities of employing the roentgen unit in practical radiation therapy. For technical reasons, the dose is best measured in the free roentgen beam. The "roentgen value" is defined as the number of R per minute contained by the beam under examination at a focal distance of 30 cm. The scattering in relation to the radiation quality and field size can be read off from a predetermined table or curve. Such data have been determined by the author for radiations of medium and hard rays.

The measure of the quality of radiation can be suitably determined by measurement of absorption and determination of the semithickness value of copper. This value is not only easily determined by the same instrument used for measuring dosage, but is also directly related to the *percentage depth dose*, the most important value for practical purposes, and for the sake of which the quality of the radiation has to be determined. The German and French R units are compared and the viewpoint is taken that the German unit as an absolute measure is more exactly defined and is independent of external conditions. On the other hand, it seems desirable to employ the constant activity of radium for checking the constancy of sensitiveness of the measuring apparatus (secondary calibration).

With the biological method of dosage measurement (using *Ascaris* ova), it was found that within the hardness range of 100 to 200 kv. equal numbers of roentgen units correspond to equal biological effects as expressed in the percentage injury to embryonic development of the *Ascaris* larvae.

JERMAN, E. C. One hundred milliampere Bucky diaphragm technic. *Radiology*, July, 1926, vii, 59–61.

For roentgenographing the kidney the author recommends the anteroposterior position at 25 inch distance, 65 kv. peak, 100 ma. for 2 sec. with a 5–100 tube. Compression by means of a rubber bladder, air inflated, is almost universally employed. For the stomach, colon and gall-bladder the posteroanterior position is recommended, distance 25 inches, 100 ma., with 1 sec. exposure. For the stomach and colon the voltage recommended is 84 kv. peak, and for the gall-bladder it is 76 kv. peak. The above figures are based upon average adult weighing 150 pounds. An accurate time switch and a stabilizer are essential for satisfactory results.

JERMAN, E. C. Frontal sinus and mastoid technic. *Radiology*, August, 1926, vii, 164–165.

A good roentgenogram of the frontal sinuses should show clearly and well defined the border walls and the septa of the sinuses. The frontal sinus area should be darkened slightly and should show a somewhat greater density than the surrounding bony structure. The ethmoid sinuses should be shown quite clearly. If the nose-chin position be used the maxillary sinuses should be clearly outlined with proper density.

With a Potter-Bucky diaphragm a distance of 25 in. is suggested. Without the diaphragm a 30-in. distance is suggested for the purpose of increasing the quality of detail. Ten ma. through a 5–10 radiator tube is suggested in order that good detail may be obtained. The posteroanterior position is recommended with the tube operated at 87 kv. peak, 15 sec. exposure when a Bucky diaphragm is used, and 74 kv. peak for 10 sec. without the diaphragm. A cone 5 in. in diameter and 10 or 12 in. long is ordinarily employed along with the Potter-Bucky diaphragm; and a cone 3 in. in diameter (at the larger end) and 6 or 7 in. long is ordinarily employed when not using the diaphragm.

A good roentgenogram of the mastoid should show the complete lateral contour of the mastoid area as well as the complete cellular structure of this area. All septa should be clear and distinct. The technique should correspond with that outlined above for the frontal sinuses. The mastoid is roentgenographed in the lateral position with 87 kv. peak for 5 sec. with a Bucky diaphragm and at 70 kv. peak for 5 sec. without the Bucky diaphragm.

LINSBAUER, K. Roentgenological studies on mosses and ferns. II. Developmental stage. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, February, 1926, xxxiv, 265–287.

The gametophytes of liverworts and ferns react to roentgen irradiation of 2 to 5 H and upward, with a retardation of growth, but an increase of the dose even up to 40 H causes no necrosis to appear, those cells receiving the maximum dose appearing only to go more prematurely over to the permanent stage. The germination of spores of *Fegatella* and gymnograms is neither inhibited nor delayed by

strong irradiation (40 H). The inhibitory reaction is first noticed in germ embryos of *Fegatella* during the transition to the dorsiventral state.

Those growth processes which depend primarily upon enlargement of cells (increase in volume of the cell elements) are not affected by the irradiation. The development of the rhizoids, the extension of the sporangiophore of *Fegatella*, the first development of budding cells and the germination of the spores, all proceed normally in irradiated specimens.

Single irradiations appear to be accumulated in a typical manner. The sum of the individual doses delivered at intervals of twenty-four hours appears to have a smaller effect than a single dose of the same total magnitude. It was found that four doses of 5 H each gave the same effect as that produced by a single dose of 10 H. A summation of single irradiations on the liver wort thallus results in the production of an enforced hibernation, but in this case the plant remains unmatured. This is regarded as proof of a physiological difference between the state of true latency and enforced hibernation.

Irradiations of the budding cells of *Lunularia* causes changes in the growth in the sense that the primary thallus, ceasing its ordinary growth (with doses of 5 H and upward), shows one or more adventitious structures which may lead to the development of secondary growths. Similar effects are produced upon fern prothallia. These secondary structures appear to develop normally and yield normal sporophytes, a fact which proves that these structures have developed from the cells injured by the roentgen rays.

Cells in the stage preparatory to division are able to continue the process of division even after irradiation, but usually there occurs a twenty-four hour interval in which no division takes place. After this period all cells of the prothallium may undergo one or more further divisions. This fact indicates that even cells with resting nuclei can be affected by irradiation. It has already been noted that older cells which normally do not undergo division appear to be immune to roentgen injury. In other words, the roentgen sensitivity of cells decreases as they pass from the embryonal to the permanent stages.

The proliferations in the thallus produced by irradiation are due to the disturbance of the normal center of division whereby in place of a harmonious development there arises a series of independent foci of development not subordinated to each other. The reason for this appears to be not the development of necrohormones, but the disappearance of correlating inhibitions.

LORK, ERICH. The question of the origin of roentgen sickness. *Strahlentherapie*, 1926, xxii, 184–188.

The protective lead inclosures furnished by Siemens and Halske assure an uncontaminated atmosphere in the roentgen treatment room (provided there is adequate ventilation around the apparatus), but in the experience of the author this installation does not completely eliminate the occurrence of roentgen sickness in patients. It does seem, though, that the frequency and intensity of these symptoms are less than those which occurred before the installation. It therefore follows that so-called gas poisoning cannot be the sole cause for the occurrence of roentgen sickness. It is also pointed out that the nurses and roentgen therapists constantly present during treatments have never shown any signs of general disturbance.

LOSSEN, HEINZ, and SCHNEIDER, ERICH. Roentgenological studies of the gastric canal. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, February, 1926, xxxiv, 252–261.

Silver beads were carefully attached to the exterior of the gastro-duodenal passage in a dog so as to outline the position of the walls in the roentgenogram. The animal recovered from the operation and subsequent experience showed that the presence of the beads caused no unusual symptoms. Feeding experiments were then instituted and serial roentgenograms taken.

The pictures show clearly that in the dog the newly swallowed food first passes exclusively over the small curvature. As more food reaches the stomach the gastric musculature is put under strain and thus appears to be contracted around the food.

The roentgen pictures also show clearly that in the dog, as well as in man, there is a distinct antrum formation which in structure and function seems to be fundamentally alike in both species. The conclusion from the experiments is that the function of the Waldeyer canal in the stomach can be easily demonstrated roentgenographically in the dog. The interpretation of this function from a purely mechanical point of view appears to be somewhat more difficult to understand in the dog than in the case of the human who walks erect.

MOONEY, BERNARD R. A simple method of preparing gelatin capsules of tetraiodophenolphthalein. *Radiology*, August, 1926, vii, 167–168.

Size No. 2 gelatin capsule is packed with 8 grains of the dye, dipped in a 10 per cent solution of formaldehyde and allowed to become

nearly dry (sticky) by exposure to the air. It is then inclosed in a larger capsule, a No. 0. Glutoid, formed by the action of formaldehyde on gelatin becomes very insoluble if allowed to dry. This is the reason for covering the partly dry capsule with a larger sized dry one. The dipping very effectually seals the capsule. The capsules should be freshly prepared and exposed to the light as little as possible. The dose is 20 to 40 grains of the dye, depending on the weight of the patient.

It is claimed that nausea, vomiting and diarrhea are not so often noted after the preparation of the dye as above outlined. In the last 50 routine cases nausea occurred five times, vomiting twice, and diarrhea not at all. Gallbladder shadows on the plates are uniformly better when produced by the above capsules.

OSLUND, ROBERT M., and BACHEM, ALBERT. Germinal epithelium in x-rayed testes of rats. *Proc. Soc. Exper. Biol. & Med.*, May, 1926, xxiii, 761.

Rat testes were exposed to graded doses of roentgen rays and studied up to six months after exposure. Doses up to 10 erythema doses were given at one time. The extent of degeneration produced in the seminiferous epithelium was found to depend roughly upon the amount of irradiation. Actively dividing cells, spermatocytes and then spermatgonoia are the most easily injured. Spermatozoa disappear for a short time (about 10 days) after exposure. Their absence marks the time required for conversion of spermatogonia into spermatocytes, then to spermatids, and finally to spermatozoa.

Doses exceeding 3 E. D. cause aspermatogenesis with degeneration of all seminiferous epithelium excepting the Sertoli cells. The latter did not succumb until 8 erythema doses or more were applied. The persisting cells gradually change in structure, and from them are produced spermatogonia. Regeneration takes place from these persisting indifferent cells, and the latter are therefore regarded as essential germ cells. Within one month considerable recovery takes place and in three to four months the testes are again normal. Since the germinal epithelium was not completely destroyed by irradiation, it cannot be said that this tissue does not take part in producing the sex hormone in roentgenized animals.

POPE, CURRAN. The treatment of roentgen-ray nails. *J. Am. M. Ass.*, July 24, 1926, lxxxvii, 242.

Roentgenographers' nails usually present a trophic appearance, being rough, ridged and dirty. The treatment suggested by the author gives excellent results but requires patience and perseverance. The hands and nails are cleansed with a soft brush and good soap. The hands are bathed in very hot water and then immersed in very cool water and rubbed dry with a crash towel. The entire hand is anointed with olive oil and the oil is worked into the nails, especially their corners and edges by means of an orange wood stick. This had best be done in the evening, the surplus oil left on the fingers and a pair of gloves worn during the night. In the morning the hands should be cleansed, rubbed with olive oil and the oil wiped off with a towel. After this treatment has been followed for six or eight weeks the nails should be carefully manicured, trimmed, prepared and finally glazed over. This fills the ridges, closes the pores, prevents them from cracking or breaking and prevents the collection of dirt.

PUTNAM, TRACY J. Some brominized oils for radiographic use. *J. Am. M. Ass.*, Oct. 2, 1926, lxxxvii, 1102–1104.

An investigation was made into the comparative merits of various types of halogenated oils at the Laboratory for Surgical Research, Harvard Medical School. In addition to iodipin, lipiodol and lipiodol ascendant, tests were made on the following oils after halogenation: rapeseed oil (highest specific gravity), castor oil (highest viscosity), linseed oil (high iodine value), cod liver oil (animal oil of high iodine value), poppy oil, olive oil (typical semidrying vegetable oils), neat's-foot and lard oil (the liquid portion of typical body fat), porpoise oil (low viscosity animal oil), parsley-seed oil (low viscosity vegetable oil) and spermaceti oil (lowest specific gravity, unusual chemical composition).

It was found that the animal oils are less irritating, more easily emulsified and more quickly absorbed than the vegetable oils at present in use. The various animals oils could be made sufficiently opaque for roentgenographic purposes by forming bromine substitution products instead of iodine addition compounds. In a few comparative biologic tests made with these halogenated fats it was found that they were less irritating to the tissues than air.

Lard oil containing 40 per cent bromine appears to be the most suitable of the oils tested for myelography, pneumography, etc. Lard oil containing 11 per cent bromine has a lower specific gravity than the body fluids, and might be used for ventriculography by the spinal route, to outline the surface of collections of fluid, etc.

Permanent emulsions of these oils may be made and are fine enough to be injected intravenously. They may be used in pyelography, etc. Brominized sperm oil is the darkest and at the same time the least viscous of the halogenated oils tested. It is more irritating than lard oil and does not emulsify easily, but it may find special uses.

The brominized oils like the iodized oils appear to be self sterilizing and do not become rancid on standing. They will stand high temperatures, even autoclaving without setting free bromine, but there is some danger of hydrolysis.

Rubin, I. C., and Bendick, A. J. Fluoroscopic visualization of tubal peristalsis in women. *J. Am. M. Ass.*, Aug. 28, 1926, lxxxvii, 657–658.

Tubal peristalsis in women, in spite of abundant opportunity for observation, has so far not been observed or described as occurring during laparotomy. This physiological function of the fallopian tubes has been assumed by embryologists and physiologists to be a necessary factor in the transportation of the ovum. Undoubtedly during anesthesia there is a paralysis of the muscular movements of the tubes; in addition tubal contractions are dependent on ovarian activity and unless special observation is made at favorable times the motions of the tubes may be overlooked. Moreover the motions are slow at best and appear to be slower in humans than in the lower animals.

The observations made by the authors were upon patients in whom peruterine tubal insufflation with carbon dioxide had demonstrated the fallopian tubes to be non-patent or partially blocked. Twenty-six patients were observed. Roentgenoscopic observations were made during the lipiodol injection and for several minutes after the uterine cavity and tubal lumina were filled by the fluid. Films were taken at the same time, one-half hour later and again at later periods for several weeks. With the exception of 2 cases, 5 c.c. of fluid was sufficient to fill the uterine cavity and the tubes to full length. In 2 cases the cavity held more than 5 c.c. and the quantity used was doubled.

The results of examination in 24 of the cases were clear. Of these – were blocked close to the uterine wall. In 1– cases one or both tubes were visualized. Fifteen of these showed peristalsis which could actually be watched under the roentgenoscope, and evidence was obtained on the films by the distinct beading described by Dryoff as "pearls."

Roentgenologically the lumen of the tube can be divided into two portions, the first a fine hair-like process extending from the uterine cavity a distance of 1 to 3 inches. Its course is usually downward and outward and is fairly straight. The second portion from 1 to 4 inches in length is tortuous and more or less dilated, corresponding to the ampulla and ovaries. The first portion does not show any peristalsis. It empties and fills but no rhythmic action can be seen. The second portion corresponding to the ampulla displays peristaltic motion.

Three types of motion are encountered: (1) the passage of lipiodol through the tubes as a result of pressure exerted by the injecting syringe. This movement is slow, somewhat irregular and goes from uterus to fimbria. (2) A worm-like twisting or writhing action of the tube, which may be due either to a contraction of longitudinal muscle fibers alone or in conjunction with a movement transmitted from adjacent viscera. (3) A true peristalsis showing as a distinct beading which travels in a wave-like motion starting at the fimbria and progressing toward the uterine cavity. Its rate varying in different subjects is from five to nine per minute. It could not be seen in all subjects and was seldom seen as soon as the tube showed dilatation. Whether this rate is normal or whether it is a response to a foreign material (lipiodol) in the tube, is impossible to state, but it proves that the tube is capable of rhythmic regular peristalsis extending toward the uterine cavity.

v. Salis, H. Materials protective against roentgen rays. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, February, 1926, xxxiv, 317–321.

A research has been going on for a number of years on the experimental development of material suitable for the construction of light gloves, caps, masks, covers, etc. Metal was incorporated in its colloidal form in textiles or rubber, instead of the metal salts or oxides previously employed. The metal was treated by the Clavel process for the production of highly colloidal particles. It was found that the greater the degree of dispersion of the metal, the greater the degree of its protection against roentgen rays.

Silk, wool and cotton treated in various manners showed different degrees of opacity to roentgen rays, but in no case were they sufficiently protective as compared with customary leaded rubber. Attempts to increase the number of layers of fabric to increase roentgen opacity caused a loss in flexibility. The treatment given to the textiles affected their dura-

bility. Thin rubber gloves containing colloidal metal were found to be useless because of their brittleness and stickiness.

SANTE, L. R. An indexing system for the cataloguing of pathological films. *Radiology*, August, 1926, vii, 149–163.

None of the classifications of disease or causes of death in general use can be employed in roentgen-ray classification since they are not adapted to the wide range of conditions. The author presents a classification which takes into consideration not only disease conditions but pathological signs or symptoms and may be modified to include any special investigation desired by the individual roentgenologist. This system in brief is a modification of the Dewey Decimal System applied to the roentgenologist's needs.

The various anatomical systems are numbered and all diseases of pathological conditions are grouped under the various systems wherever they belong and are numbered with decimals. Each number, with the disease condition which it represents is placed upon a card and records of all cases of this disease are entered upon this card. The films remain in the general file, this indexing system merely giving information as to where they may be found.

SCHEPMANN, W., and FLECKE, H. On the effect of "extra soft" roentgen rays upon bacteria. *Klin. Wchnschr.*, Aug. 27, 1926, v, 1608–1611.

Experiments were performed on the comparative sensitivity of certain bacteria to extra soft and hard roentgen rays. The extra soft rays were produced by a Müller tube containing a copper anticathode and provided with a Lindemann window. This tube was operated at 10 ma., 50 kv. effective; the average wave length of the unfiltered rays was found to be 1.29 Å. The focal distance was 16 cm. and the intensity of the rays measured with an ionization chamber 25 cm. in diameter was 36.1 R per second.

The hard rays were produced by a Metro tube operated at 7 ma., 80 kv. effective, at a focal distance of 12 cm. The organisms tested were *Micrococcus pyogenes aureus*, *Bact. coli*, *Bact. pyocyaneum*, *Bact. prodigiosum*, and *B. mesentericus*. Cultures were freshly inoculated upon agar plates and exposed to the rays. After inoculation the plates were dried for a short time in a current of warm air and then exposed. Only a small portion of the plate was exposed to the rays, the remainder acting as control.

Incubation of the control plates for twenty-four hours showed the usual dense bacterial growth but the irradiated zones showed different pictures. Where the bacteria were killed off there was a large round sterile zone in the agar surrounded sharply by the profusely growing culture. Where the dose was inadequate for complete killing the growth was slight, and inversely proportional to the intensity of the dose. The results show that different lengths of time are required for a complete killing of the various bacteria. *Bact. prodigiosum* was completely destroyed in three minutes, while with *Bact. pyocyaneum* only 80 per cent were killed during three minutes' exposure. *Bact. coli* was only 70 per cent destroyed in five minutes, while the staphylococci required ten minutes for a 75 per cent destruction. At no time was there observed any growth stimulation induced by very short exposures.

The spore-former, *B. mesentericus* acted a little differently. When irradiated immediately after inoculation on the plate (the streaks containing only spores) about 60 per cent were destroyed in forty-five minutes. When the plates were incubated at 37°C. for 1.5 hours before irradiation so as to permit some of the spores to germinate, 60 per cent were destroyed in an exposure of thirty minutes. This experiment demonstrates that the spores are more resistant than the vegetative forms to soft roentgen rays. Since an exposure time of one second corresponds to a dose of 36.1 R under the conditions of these experiments, the total dose required to produce the above effects may be easily calculated.

So far as the observations go, there were no alterations in biological function of the bacteria as a result of exposure to the extra soft rays.

Exposures with hard rays were made only upon *Bact. coli* because the time required for producing an effect upon the other organisms exceeded the life of the tube. In the case of *Bact. coli* the effect of the hard rays was about one-half that produced by the extra soft rays, the dosage in both cases being the same. Since this experiment required an exposure of several hours to the hard rays it may well be that the ozone and nitrous oxide gases in the roentgen room may have contributed somewhat to the bactericidal effect noted. These observations show a distinct specific effect of the extra soft rays upon the bacteria as compared with the hard rays.

SCHMITT, WALTHER. Again the question of injury to the offspring as a result of roentgen treatment preceding pregnancy. *Strahlentherapie*, 1926, xxi, 608–624.

A review of all the facts at present available would seem to indicate that there is no danger

to the offspring of roentgen irradiated parents, if the roentgen treatment was administered before conception.

As regards the effect upon offspring when the pregnant mother is irradiated, there are only a few cases reported that may have a bearing. In these cases, the evidence does not point absolutely to a causal relationship between roentgen irradiation and the deficiency found in the child. It must, however, also be admitted that there is no proof that the roentgen rays were not responsible for the deficiency in these offspring of irradiated mothers. It therefore behooves the careful roentgen therapist to give the patient the benefit of the doubt and not to irradiate any prospective mothers, except in such conditions as tuberculous or gonorrheal infections of the genital tract or in the larger myomas where possibility of motherhood is practically eliminated in any event. A bibliography of 36 papers is appended.

Schneider, Erich. Biological effects of roentgen rays upon unicellular organisms, from studies on *Paramecium*. *Strahlentherapie*, 1926, xxii, 92–106.

The mere change of the medium in which *Paramecium* is grown is sufficient for demonstration of a biological effect of roentgen rays upon this organism. The effect of the rays is apparently associated in some way with the electrolytes in the medium. This biological reaction occurs only within a certain zone of pH which in the case of *Paramecium* lies on the alkaline side.

When dilute sodium hydroxide was used, the roentgen effect was demonstrable between pH −.25 and −.3. When sodium carbonate was employed, the roentgen effect occurred between pH −.2 and −.5. This range was between pH −.3 and −.− when the electrolyte was sodium bicarbonate.

The effect of the roentgen rays at the lower limit of the effective range (pH −.25 to −.3) is apparently of a stimulating nature, but at the higher pH values the effect is distinctly depressive and lethal or disruptive, and moreover nonspecific.

The paramecia were irradiated either in hay infusion or in a watery suspension. Three different doses were administered. The roentgen apparatus was operated at 4 ma., 41 cm. parallel spark gap, potential-hardness meter 130 to 200 kv., no filter, 23 cm. focus distance. It was found that such an irradiation for 13 to 39 minutes produced no demonstrable effect upon the paramecia. In this case the pH of the surrounding medium was −.0. Apparently the enormous quantity of radiation administered had no effect at this acidity. This resistance to radiation was found definitely related to the pH of the surrounding medium.

Schoenholz, L. Demonstration of intracranial hemorrhages in the dead newborn without autopsy. *Klin. Wchnschr.*, Sept. 17, 1926, v, 1775–1777.

The method suggested by the author consists in the injection of a plastic shadow producing mass which will distribute itself in the cranial spaces and reveal on the roentgenogram the localization of the hemorrhages. The fetus is placed in physiological saline, kept at 40°. The contrast material consists of a mixture of 60 parts red lead, 100 parts water, 20 parts gelatin and 20 parts chalk. Both jugulars are exposed and on one side the vein is ligated below, and is injected cranially with the material which has been held ready in a record syringe, kept at 40° in order to keep the material fluid. The injection is finished when the jugular at the other side shows the appearance of the red fluid. The vein is then ligated above the site of injection to prevent outflow of the red lead.

Excellent pictures of the vascular system are obtained when the same method of injection is followed on the other side, the injection being continued until resistance is encountered. Of course excessive pressure must be avoided in order to prevent artificial injuries. Experiments were made on cases that could be autopsied to confirm the fact that the injection mass extravasated only where there was a previous defect in the vascular system. In certain cases where the cause of death was entirely clear and was not due to any intracranial hemorrhage the injection mass was never found to break through the vessel walls. Stereoroentgenograms give especially beautiful pictures of the distribution of the vessels and of the types of hemorrhage where they occur.

Schreus, H. Th. The biological determination of scattered radiation from hard roentgen rays for the correction of the measurement error of physical dosimeters. *Klin. Wchnschr.*, Sept. 17, 1926, v, 1762–1764.

Measurement was made of the scattered radiations from different sized surfaces by the Siemens dosimeter and the iontoquantimeter of Reiniger, Gebbert and Schall. The radiations were produced by a Veifa Neo-Intensiv-Reform apparatus operated on direct current, 215 kv., 30 cm. distance, 3 mm. Al or 0.5 mm. Cu. The readings on the two instruments were entirely different and no conclusion could be reached as to which represented the true values. The measurements did show that the scattered radiation increased with the size of the field.

It is of practical importance to know which of the indicated values is correct and the author sought to determine this by means of biological experiments. The biological indicator employed was the root reaction of bean and pea seedlings. The biological experiments showed that the readings given by the iontoquantimeter were considerably higher and those of the Siemens dosimeter were also somewhat higher than indicated by the response of the seedlings. Assuming that the seedling reaction runs parallel to the tolerance of the human skin it may be said that the scattered radiation measurements made with the iontoquantimeter for purposes of calculating the actual dose on the surface of the body are less suitable than those made with the dosimeter, which also gives readings that are still too high. The biological tests show that increase of the field size increases the amount of scattered rays and suggests a decrease of the calculated time of irradiation from the dose measurements made in the air without a scattering body. However, the magnitude of the correction for scattered radiations is considerably less than that indicated by the small ionization chambers. Although the observations have been made with the aid of plant seedlings, the data appear to be applicable in practical human therapy.

SEYNSCHE, KARL. Germinal gland irradiation and offspring. *Strahlentherapie*, 1926, xxi, 600–607.

A report is given of a case occurring in a woman aged thirty-seven who received a castration dose for the treatment of acute menorrhagia. Permanent amenorrhea did not, however, occur and the woman gave birth to a child two and a half years after the irradiation. This child at birth showed nothing unusual except for a somewhat small sized head. However in a short time a pronounced microphthalmos appeared and developed shortly into a typical mongolism. The author points out that there is no proof of cause and effect between the irradiation and the birth of the abnormal offspring.

In addition 2 other cases are described briefly in women, whose husbands had been under prolonged exposure to roentgen rays, who gave birth to deficient offspring. The first occurred in a family of 5 children, the oldest seven and a half years old. The parents were both healthy, the father being a busy roentgenologist. The three older children are entirely healthy. The child two and a half years old shows mongoloid characters, and the child one year old is a typical mongoloid idiot. In the second case of a family of 3 children, thirteen, ten and five years old respectively, the parents were healthy and without history of mental deficiency in their families. The father has been working for sixteen years in a large roentgen institute and is now beginning to show signs of roentgen injury of the right hand. The two older children in this family show decided signs of imbecility while the youngest does not appear to be so much affected so far as intelligence is concerned.

In these two cases there is again no absolute proof of cause and effect, and the author expresses no opinion in this matter. The cases are merely reported for record.

The viewpoint assumed as regards the irradiation of fertile women is that so long as injury of the embryo remains a possibility there is no good justification for stimulative irradiations or for temporary roentgen sterilization of such women. In the author's clinic requests for the irradiation of girls and young women are declined.

SIMPSON, FRANK E., and FLESHER, ROY E. A new uterine screen and introducer for inserting radon tubes into the uterus. *J. Am. M. Ass.*, April 3, 1926, lxxxvi, 1005.

The screen consists of a cylindrical lead tube with a lumen just large enough to contain the radon tubes. It can be bent to conform to the curve of the uterine canal. Screens may be made in various lengths and may contain as many radon tubes end to end as needed. The wall thickness is 0.75 mm., the diameter of the lumen being 2.5 mm. Each end of the screen is fitted with a nickel plated brass screw cap with an eyelet for attaching a string.

The introducer is 30 cm. long and contains a obturator, one end of which is divided into two jaws for the reception of the screen, the other end being provided with a ring. The screen may thus be clamped in the distal end of the introducer or released from it, by pulling or pushing on the proximal end of the obturator.

From 500 to 1000 or more millicuries may be used, the time of exposure being about one to three hours, depending on the quantity of emanation. In making intracervical applications with the above device, dilatation is seldom necessary and trauma is thus minimized. Repeated bending of the screen tends to weaken and break it, hence the lead tube should be renewed frequently.

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PAUL B. HOEBER, INC., 76 Fifth Avenue, New York

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JUL 8 1927

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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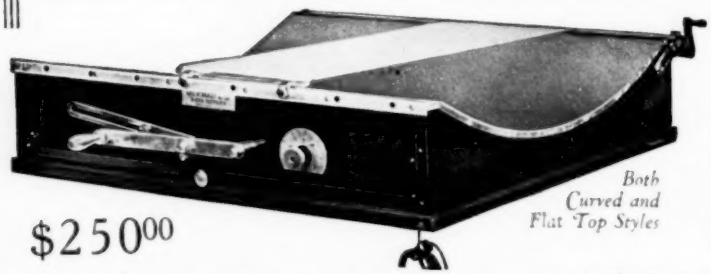

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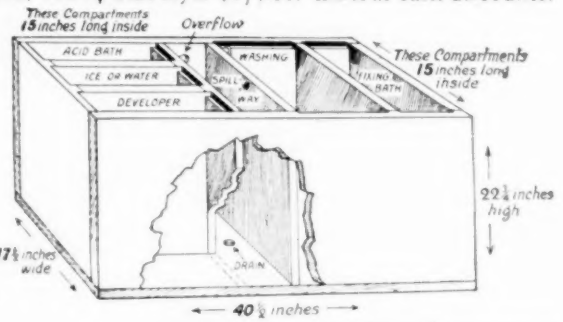

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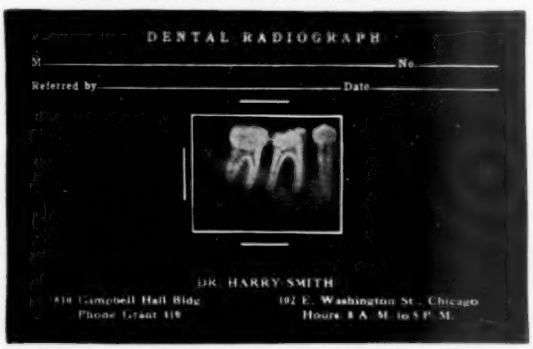

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